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THE ROENTGENOLOGIC DIFFERENTIATION BETWEEN HYPERTROPHY OF THE PROSTATE AND VESICAL UROLITHS[1]

by

Axel Renander

The vesical uroliths opaque to the roentgen rays are usually easy to diagnose. As a rule they appear as characteristic concretion shadows in roentgenograms of the true pelvis. The differentiation between these calculi and all the various formations (calcified areas in the uterus, the prostate, the blood vessels, the lymph nodes, the appendices epiploicae, the wall of the bladder, and the ligaments; contrast medium in the intestines and pills, etc.) that may come into question in this connection is generally understood and will not be discussed herein.

What is perhaps less well known is that lobes of the prostate sometimes are visualized inside the bladder in forms that can lead to their being mistaken for organic vesical uroliths. PALUGYAY mentioned this phenomenon in a paper published in 1932. HAAS and FILLENZ described two cases in which roentgen examination revealed a calculus-like formation in the bladder, which cystoscopy showed to be a lobe of the prostate. And KNEISE and SCHOBER in their monograph reported on two cases in which the prostate was entirely surrounded by contrast medium and gave the impression on the roentgenograms of a free calculus. The following two cases, which I recently diagnosed wrongly, are intended further to illustrate the difficulties of differential diagnosis on the basis of the roentgen findings in cases of this kind:

Case 1. A man of 62 years (S. W., Record No. K. 2273/44) had for twenty years had slight diuresis and nocturia (once). He came to Centrallasarettet not because his condition had taken a definite turn for the worse, but because ten days previously he had passed a pea-sized clot of blood with urine.

[1] Submitted for publication, Febr. 13, 1945.

From the Roentgen Department of Centrallasarettet, Västerås, Sweden (Physician-in-chief: AXEL RENANDER).

Local examination: Palpation revealed the prostate to be moderately enlarged and to be tensely elastic in consistency.

Roentgen examination: No concretions were visualized in the general roentgenogram of the true pelvis.

Urography: A goose-egg-sized, egg-shaped rarefied area (Fig. 1) was seen in the shadow of the bladder. Its position in the bladder was somewhat proximal, and it appeared to be completely surrounded by contrast medium.

Air cystography: Corresponding to the above-mentioned goose-egg-sized formation in the bladder could be seen a positive homogeneous shadow, contrasting with the air (Fig. 2). Here, too, the whole circumference was clearly outlined with no hint of a stalk. In addition, the formation seemed to have been displaced caudally (compare position in Figs 1 and 2 in relation to the visible phlebolith).

On the basis of the above findings, I unhesitatingly made the diagnosis, organic urolith the size of a goose's egg.

Operation a few days later disclosed the surprising fact that the formation interpreted as a urolith in reality consisted of an enlarged lobus tertius prostatae.

Case 2. A man of 71 years (K. G. A., Record No. K. 2009/44) had had prostate trouble for a few years. He usually urinated twice nightly.

Local examination: The prostate was normal in size, elastic, and distinctly outlined from its surroundings.

Roentgen examination: No concretion shadows were visualized in the general roentgenogram of the true pelvis.

Air cystography: A plum-sized, homogeneous, positive shadow was seen contrasting with the air in the bladder (Fig. 3, an oblique projection). The oval shadow had an unbroken outline and was situated caudally in the bladder.

Urethrography with iodized oil was done at the same time. In the oblique position, a few drops of the oil could be seen lying asymmetrically at the pole of the rounded formation (Fig. 4), while in the supine position there was a narrow band of oil encircling the caudal pole.

This case also was diagnosed roentgenologically as organic urolith.

Operation, however, disclosed that the formation presumed to be a calculus actually consisted of an enlarged lobus tertius prostatae.

Thus, in both these cases a hypertrophic lobe of the prostate bulging into the bladder was interpreted roentgenologically as a urolith consisting of organic salts.

In all probability these are not the first mistakes of the kind to have been made, and as mentioned in the foregoing, the difficulties in certain cases of differentiating between a hypertrophic lobe of the prostate and a calculus have already been mentioned by PALUGYAY and later by HAAS and FILLENZ also.

PALUGYAY pointed out that it should be possible to avoid mistakes — this obviously applies only to calculi not opaque to roentgen rays — if it is borne in mind that the shadow of a vesical concretion always lies one to three centimeters cranial to the caudal contour of the air-filled bladder, corresponding to the trigonum vesicae. Furthermore, PALUGYAY found in later examinations of his wrongly diagnosed cases that the caudal margin of the prostate lobes could not be differentiated or distinguished

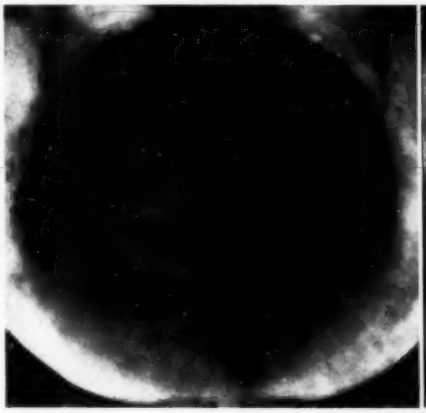

Fig. 1.

Fig. 2.

from the caudal contour of the bladder. On these grounds, he expressed the following opinion: *»dass in allen Fällen, in denen wir die ganze, auch kaudale Begrenzung des auf Stein verdächtigen Schattens in der luftgefüllten Blasenaufhellung deutlich wahrnehmen, ein hypertrophischer Prostatalappen differentialdiagnostisch nicht in Betracht kommt.»*

My cases suggest, however, that PALUGYAY was wrong in his assumptions. The outline of the entire formation, including the caudal margin can be clearly distinguished in both Figs. 1, 2 and Fig. 3. In Fig. 1 the shadow even seems to be situated more proximally than caudally in the bladder, despite the fact that it represented a lobe of the prostate. Nor is this circumstance difficult to explain theoretically: it is obviously purely a question of projection. If we were to inspect the enlarged prostata lobe bulging into the bladder from above, the stalk would be concealed by the lobe. In photographing the bladder, the tube is generally centered somewhat from above, which means that the caudal margin of the invading prostate visualized on the radiogram actually is a part of the anterior surface of the lobe of the prostate. The stalk is thus obscured, and the lobe therefore appears as a free formation in the bladder.

PALUGYAY's claim that a hypertrophic lobe of the prostate does not change its position in the bladder with changes in the patient's position carries more weight. However, care must be taken to avoid misinterpreting apparent changes in position, as I did in Case 1. Even though the cranial angle of the central ray with the vertical plane was the same in Figs. 1 and 2, Fig. 2 was taken with the patient in the oblique position, and there was therefore rotation around the vertical axis at the same time. This explains in part the apparent craniocaudal displacement of the pros-

Fig. 3.

Fig. 4.

tate lobe (compare position in relation to the phlebolith visible in Figs. 1 and 2). Furthermore, the contrast medium in which the prostate lobe lay was *uroselectan* in Fig. 1 and air in Fig. 2. The shape of the bladder would therefore be affected in different ways in the two cases — the heavy *uroselectan* tending to weigh down the bladder and the air tending to lift it up. Asymmetry would also develop in the oblique position, and make it difficult to decide whether the formation is really or not being displaced.

Fixation to the floor of the bladder suggests a lobe of the prostate, even if, as in the above cases, the caudal margin can be distinguished. If this circumstance had been taken into consideration in my cases, wrong diagnosis could probably have been avoided. Further, if a calculus had been present in Case 2, presumably it would, like the drops of oil, have settled at the lowest point in the bladder (Fig. 4). It must be assumed that a calculus would have lain on the top of the drops of oil and, therefore, have been partly immersed in the latter and not, as here, have been projected beside them. Here we probably have a possibility of distinguishing between a moveable calculus and a hypertrophic lobe of the prostate in cases of this kind.

The two cases described herein thus prove that hypertrophic lobes of the prostate can be confused with uroliths that are not opaque to the roentgen rays and that, depending upon the projection, a circumscribed lobe of the prostate can sometimes be distinguished in the roentgenograms with no visible break for the stalk. If the formation is seen to be attached to the caudal floor of the bladder when the patient changes position, there is good reason to believe that a lobe of the prostate is present rather than a calculus.

SUMMARY

Two cases are described in which the lobus tertius prostatae was mistaken in the roentgenograms for non-roentgen-opaque uroliths in the bladder. The risk of making this mistake is particularly great when unbroken outlines of the hypertrophic lobes of the prostate can be distinguished with no suggestion of a stalk. Fixation to the caudal floor of the bladder indicates the presence of a lobe of the prostate rather than a calculus.

ZUSAMMENFASSUNG

Es werden zwei Fälle beschrieben, bei denen der Lobus tertius prostatae in den Röntgenbildern irrtümlich für einen röntgendurchlässigen Harnstein in der Blase gehalten wurde. Die Gefahr, dieses Irrtum zu begehen, ist besonders gross, wenn ununterbrochene äussere Konturen des hypertrophischen Prostatalobus zu sehen sind, ohne Andeutung eines Stieles. Fixation an den kaudalen Blasenboden spricht eher für das Vorliegen eines Prostatalobus als für einen Stein.

RÉSUMÉ

L'auteur décrit deux cas dans lesquels on a pris dans le rœntgenogramme le lobe moyen de la prostate pour des calculs vésicaux transparents aux rayons de roentgen. Ce risque d'erreur est particulièrement grand lorsqu'on peut distinguer les contours continus des lobes hypertrophiques de la prostate sans rien voir qui suggère un pédoncule. L'adhérence au bas-fond vésical indique la présence d'un lobe de la prostate plutôt que d'un calcul.

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FROM THE ROENTGEN DIAGNOSTIC DEPARTMENT OF KAROLINSKA SJUKHUSET, STOCKHOLM
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A CASE OF ROENTGENOLOGICALLY OBSERVED PERIRENAL OEDEMA AFTER THERAPY WITH SULPHANILAMIDE PREPARATIONS[1]

by

Olallo Morales

In connection with treatment with sulphanilamide preparations, it happens not unfrequently that complicated changes occur in the urinary ducts. These changes may be localized in the renal parenchyma, the pelvis or the ureters. They consist chiefly of oedema, necroses, haemorrhages and venous thromboses and are produced partly by toxic, partly by mechanical action, owing to the precipitation of sulphapyridine crystals. These crystals, if they occur in large numbers, may also conglomerate into concrements.

The author has recently observed yet another complication from the urinary ducts in connection with sulphanilamide medication, namely a perirenal oedema. So far as I am aware, no such complication has been previously described in the literature, and as the roentgen-picture partly resembled a perinephritis, I consider a detailed account of the case to be of value.

The case was one of a woman aged 37, who was affected with a bronchial infection, accompanied by fever. The disease was regarded as a bronchopneumonia, and sulphathiazol (4 + 2 + 2 + 2 tablets = 5 g) was prescribed. The patient, however, had vomitings and persistent pains in the back. This medication was therefore discontinued, and on the following day sulphapyridine (4 + 4 + 4 + 4 + 2 + 2 + 2 tablets = 11 g) was administered, instead. Nausea and vomitings, however, set in again, for which reason the medicine on the following day was replaced by septipulmon in injections (1 g every 4th hour, altogether 7 g) and next day by sulphadimin per os. The patient, however, received only 1 g of the last-mentioned preparation, as the pains in the back were greatly accentuated, radiating down towards the bladder. The urine sediment contained an abundance of red cells and sulphapyridine crystals. In the blood the number of white cells was 11,200, of which 9,000 were polynuclear cells. The sulphanilamide medication was then immediately discontinued, the supply of fluid was further

[1] Submitted for publication, Dec. 15, 1944.

increased and bicarbonate in ample doses (5 g × 3) was administered. The pains were mitigated with skopyl and eupaverin. By these measures, the crystalluria was caused to disappear within the course of a week and the pains in the lumbar region gradually subsided.

No roentgen-examination of the urinary ducts was performed in connection with the accentuated abdominal disorders. Not until the day after the medication with sulphanilamide had been discontinued and the disorders had begun to subside was the patient sent to the Roentgen Department for examination of the abdomen. On radiograms of the abdomen the right side was found to be of normal appearance. On the left side, on the other hand, neither the renal nor the psoas contours could be distinguished. No concrements could be observed. In the lumbar spine there were no visible changes and no scoliosis could be observed. The diaphragm dome moved freely on both sides, and no fluid exsudate could be seen in the left pleura nor any atelectasis on the left lung base. A normal urogram was recorded on the right side. On the left side, however, no excretion of the contrast or any increased density of the kidney could be found. In view of the above-mentioned roentgen finds, the roentgenological diagnosis was perirenal oedema.

Three days later cystoscopy was performed. A markedly blistered oedema, which prevented the introduction of a catheter, was then seen round the mouth of the left ureter. After another five days, the cystoscopy was renewed. The oedema had then considerably diminished, so that the catheter could be introduced without difficulty into the left ureter. Through the catheter, urine dripped at the normal pace. The urinary sediment was quite normal and contained no crystals. In connection with the cystoscopy, a retrograde pyelography was performed on the left side. It showed a perfectly normal pelvis and a normal ureter. It was still found, however, that the left renal and psoas contours could not be distinguished.

As the case was of great interest, it was decided to follow the course of development by repeated roentgenography at regular intervals. Ten days after the above-mentioned urography another roentgen examination was made, which showed that a distinct change had occurred. The left renal shadow could now be partly distinguished, and in urography a distinct excretion of the contrast was observed also on the left side. The urine, however, contained considerably less contrast than on the right side. No impediment to the passage of the urine could be observed. Though part of the kidney on the left side showed up clearly, (but less distinctly than on the right), it was still impossible to distinguish the left psoas contour. By this time the patient's condition had improved considerably and the pains in the back had almost disappeared. Also the number of white corpuscles, which had previously been abnormally large, as well

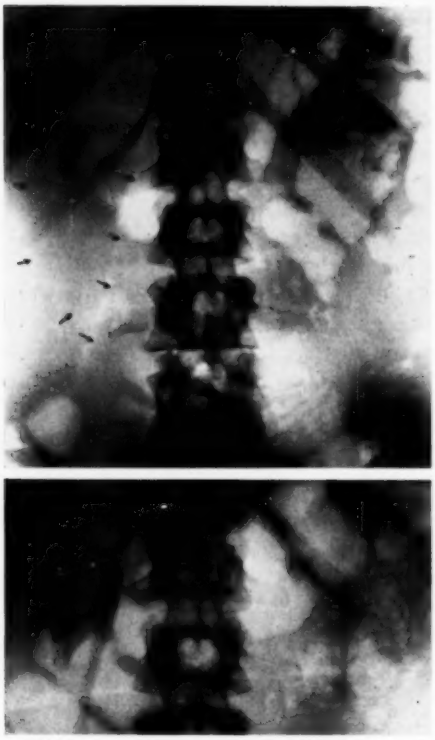

Fig. 1.

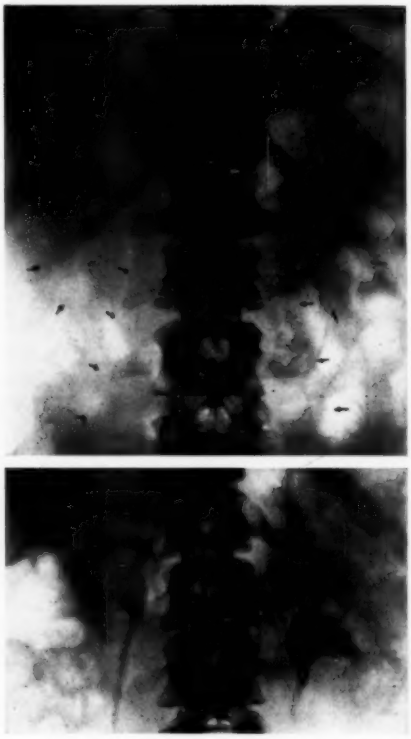

Fig. 2.

Fig. 1. The first urography showing the defaced renal and psoas contours and missing excretion on the left side.
Fig. 2. After recovering showing normal conditions.

as the sedimentation reaction, had now fallen to normal values. Only the temperature was still sligthly subfebrile in the evenings.

In the next roentgen examination of the kidneys, after another interval of ten days, the picture had again changed. The renal and psoas contours on the left side showed up quite normally, and in urography a uniform excretion of the contrast was observed on both sides. Subjectively speaking also, the patient had recovered entirely and was discharged from the hospital a few days later as completely restored.

Epicritically, the case may be summarized as follows: A female patient, aged 37, who previously had always been in good health, receives a shock dosage of sulphanilamide preparations, as a remedy for a sus-

pected bronchopneumonia in the course of 4 days, altogether 24 g. The sequels to this medication are pains in the left renal region, crystalluria, haematuria, and oliguria; roentgenologically, a perirenal oedema and a deficient excretion of contrast on the left side. Cystoscopy shows a blistered oedema round the mouth of the left ureter, and there is a polynuclear leukocytosis. By an abundant supply of fluid and bicarbonate medication the clinical symptoms are gradually abolished, whilst the patient's general condition is improved. Parallel with this, the roentgenological changes successively disappear, so that after about a month both the picture and the function of the kidneys are roentgenologically normal.

The pathologico-anatomical picture in renal lesions in connection with the medication of sulphanilamide preparations has been described by several authors, including, quite recently, BERGSTRAND. According to BERGSTRAND a considerable oedematous swelling of the kidney is observed, with haemorrhages in the parenchyma and in the pelvis, where, as also in the ureters, rather numerous concrement formations are observed. The microscopic picture is very typical, with changes in the renal ducts and their immediate environment, whereas the glomeruli are usually quite intact. The changes are marked by a focal destruction of the renal ducts at the places where crystals have been precipitated. Round the crystals hyaline crescents of precipitated albumin are observed, surrounded by round cells and haemorrhages. In addition, there are losses of epithelium in the pelvis with haemorrhages, as well as inflammatory cellular infiltrates in its wall and in the hilus fat. In the vicinity of the kidney as well as in the walls of the pelvis and ureters, numerous thromboses can also be seen. According to BERGSTRAND, the above-mentioned crystal conglomerates often constitute a purely mechanical impediment to the discharge of the urine, as do the inflammatory infiltrates. He questions, however, whether the most serious impediment to the function of the kidney is not the local inflammatory oedema.

This case is of great interest, especially the roentgenological differential diagnosis. The picture resembles a perinephritis, but differs in many important respects from the picture so carefully described by LAURELL. In fact the indirect symptoms which have an important bearing on the diagnosis of a perinephritis, notably a high diaphragmatic dome with restricted mobility, pleural exsudate, basal atelectasis within the lung parenchyma and scoliosis in the lumbar spine with concavity towards the changed renal shadow, were completely missing. As all these symptoms are signs of an inflammatory irritation in the environment of the kidney, the absence of them indicates that the change observed in the renal and psoas contours on the left side was due to a perirenal oedema, which was not of a common bacterial inflammatory character.

SUMMARY

The author reports a roentgenologically diagnosed case of perirenal oedema, which occurred in connection with medication with sulphanilamide preparations. The roentgen-picture partly resembled a perinephritis with defaced renal and psoas contours, but it differed from it by the absence of the usual accessory symptoms, namely a high diaphragmatic dome, pleural exsudate, atelectasis in the lungs and lumbar scoliosis.

ZUSAMMENFASSUNG

Verf. berichtet über einen röntgenologisch festgestellten Fall von perirenalem Ödem, das im Anschluss an Medikation mit Sulfanilamidpräparaten aufgetreten war. Das Röntgenbild erinnert zum Teil an eine Perinephritis mit verwischten Nieren- und Psoasschatten, unterscheidet sich aber von dieser durch das Fehlen der indirekten Perinephritiszeichen: hochstehende Zwerchfellkuppeln, Flüssigkeit in den Pleurahöhlen, Atelektase der Lungen und Skoliose der Lendenwirbelsäule.

RÉSUMÉ

L'auteur rapporte un cas d'oedème périrénal, diagnostiqué aux rayons, développé à la suite d'une médication par préparation à la sulfanilamide. L'image radiographique est analogue à celle d'une périnéphrite avec atténuation des ombres du rein et du psoas mais en diffère par l'abscence des signes indirects de la périnéphrite: déplacement vers le haut de la coupole diaphragmatique, exsudat pleural, atelectasie des poumons et scoliose de la colonne lombaire.

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ÜBER DIE NOMOGRAPHISCHE BERECHNUNG VON RÖNTGENLOKALISATIONSWERTEN[1]

von

Sölve Stenström

Die Berechnung der geometrischen Lokalisationswerte ist sehr einfach, wenn man für alle Teile des Objektes nur einen durchschnittlichen Vergrösserungsgrad zugrundelegt. Will man dagegen den wechselnden Vergrösserungsgrad der verschiedenen Schichten eines Objekts berücksichtigen, so führt dies zu allzu langen Rechnungen, als dass man sie in der Praxis ausführen könnte. Hier soll nun gezeigt werden, dass man mit Hilfe eines Fluchtliniennomogramms solche Ausrechnungen auf einfache Art vornehmen kann, und zwar unter Berücksichtigung des wechselnden Vergrösserungsgrades.

Bei der Grösse des Fokus-Filmabstandes bei der AHLBOMschen Methode erübrigt es sich, bei Benützung dieser Methode die Dicke des Objekts zu beachten; man kann mit einer mittleren Vergrösserung rechnen, ohne dass dies zu einem nennenswerten Fehler führt. Etwas anders gestaltet sich die Sache bei Verwendung eines kürzeren Fokus-Filmabstands, wie zum Beispiel bei der LARSSONschen Lokalisationsmethode.[2] KEGERREIS hat die »effektive Parallelität» einer Anordnung als das Verhältnis zwischen Fokus-Filmabstand und Objekt-Filmabstand charakterisiert und hat diese Quoten für verschiedene Methoden errechnet. Es ist indessen klar, dass diese Zahl den Distorsionsgrad des Bildes in keiner Weise charakterisiert. Was bei solchen Messungen von Interesse ist, ist zu wissen, wie stark sich der Vergrösserungsgrad hinsichtlich der einzelnen Schichten eines Objekts ändert. Als Mass für die »effektive Parallelität» bei einem gewissen Aufnahmesystem möchte ich anstelle der eben erwähnten Relation die prozentuale Veränderung des Vergrösserungsgrades bei Verschiebung der Objektebene aus der »Normallage» um 1 cm weg vom

[1] Bei der Red. am 17.XII.1944 eingegangen.

[2] Das Folgende bezieht sich ausschliesslich auf diese Methode, die Verf. eingehend zu prüfen Gelegenheit hatte, aber das Prinzip kann natürlich bei jeder geometrischen Lokalisationsmethode Verwendung finden.

Fokus einführen. Für die verhältnismässig dünnen Schichten, die bei Augenradiographie in Betracht kommen, kann indessen diese Differenzquote ohne wesentlichen Fehler durch die Ableitung der Vergrösserung nach dem Fokus- Objektabstand ersetzt werden. Bezeichnen wir die Vergrösserung mit y, den Fokus- Objektabstand mit x und den Fokus- Filmabstand mit f, erhalten wir also $y=f/x$, woraus man $y' = -f/x^2$ erhält. Errechnet man den Wert dieses Ausdrucks zum Beispiel für die AHLBOMsche Frontalaufnahme, ergibt sich $y' = -275/250^2$ oder -0.0044, das heisst bei Verschiebung des Objekts um 1 cm gegen den Film vermindert sich der Vergrösserungsgrad um knapp 0.5 %. Für die LARSSONsche Methode[1] wird die entsprechende Zahl $-75/68^2$ oder, ausgerechnet, -0.016. Die Veränderung des Vergrösserungsgrades per cm Verschiebung erreicht hier also 1.6 %. Da die dickste Objektschnitt, die für Augenuntersuchungen von Interesse sein kann, nur eine Tiefe von höchstens 3 cm erreicht, wird also der Unterschied im Vergrösserungsgrad zwischen dem vom Film abgelegensten und dem ihm nächsten Punkt ca. 5 %. Der Fehler, der, wenn man die Veränderung des Vergrösserungsgrades nicht berücksichtigt, im ungünstigsten Fall im Endresultat entstehen kann, ist also bei letzterer Methode ca. ± 0.5 mm. Obgleich somit der Fehler recht unbedeutend ist, soll er natürlich doch vermieden werden, um den Fehler in den Lokalisationswerten nicht unnötig zu vergrössern. Dies kann, wie gesagt, auch ohne Mehrung der Rechenarbeit geschehen, wenn man sich eines nomographischen Verfahrens bedient.

Wir gehen davon aus, dass der Hauptstrahl beim Profilbild in der Ebene des Indikatorrings liegt und auf dem Frontalbild mit der Augenachse zusammenfällt, und wollen nun zunächst den senkrechten Abstand des Fremdkörpers vom Indikatorring (x) und von der Augenachse (r) berechnen. Berechnet man ausserdem den Abstand (l) der Hornhautkuppe vom Indikator, so ist hierdurch die Lage des Körpers im Verhältnis zur Hornhautkuppe bestimmt, und man kann natürlich eben hierdurch seine Lage im Verhältnis zur Begrenzung des Bulbus berechnen, wofern die Grösse des Bulbus bekannt ist. Der Meridian, in dem der Fremdkörper liegt, kann selbstverständlich ohne Umrechnungen unmittelbar vom Frontalbild abgelesen werden und braucht daher im weiteren nicht mehr in Betracht gezogen zu werden.

Die auf den Filmen gemessenen Strecken bezeichnen wir mit griechischen Buchstaben gemäss Figur 1 und die gesuchten Abstände mit den entsprechenden lateinischen Buchstaben wie oben. Bezeichnen wir weiter für die Profilaufnahme den Fokus- Filmabstand mit f' und den Abstand vom Fokus zur Ebene des Indikatorrings mit a', so erhält man

[1] Der Wert bezieht sich auf die Versuchsapparatur, die im Sahlgrenschen Krankenhaus verwendet wurde.

Fig. 1 a.

a. Indikatorring, b. Hornhautkuppe, c. Fremdkörper.

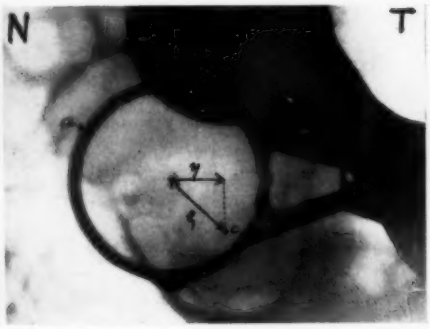

Fig. 1 b.

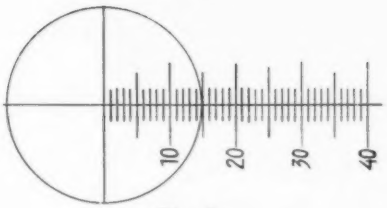

Fig. 1 c.

mit Hilfe einer einfachen geometrischen Überlegung für die Berechnung von x und r aus den gemessenen Strecken folgendes Gleichungssystem:

$$x = \frac{a - y}{f} \cdot \xi \quad \ldots \ldots \ldots \ldots \quad (1)$$

$$y = \frac{a' - x}{f'} \cdot \eta \quad \ldots \ldots \ldots \ldots \quad (2)$$

$$r = \frac{a' - x}{f'} \cdot \varrho \quad \ldots \ldots \ldots \ldots \quad (3)$$

Nach Vereinfachung erhält man unter Inkaufnahme der unwesentlichen Approximation, dass man die Ausdrücke $\frac{x}{f'} \cdot \eta$ und $\frac{y}{f} \cdot \xi$ in den Nennern vernachlässigt, folgende Gleichungen:

$$x = \frac{a' - \frac{a'}{f'} \cdot \eta}{f} \cdot \xi \quad \ldots \ldots \ldots \quad (1\,a)$$

$$r = \frac{a' - \frac{a}{f} \cdot \xi}{f'} \cdot \varrho \quad \ldots \ldots \ldots \quad (3\,a)$$

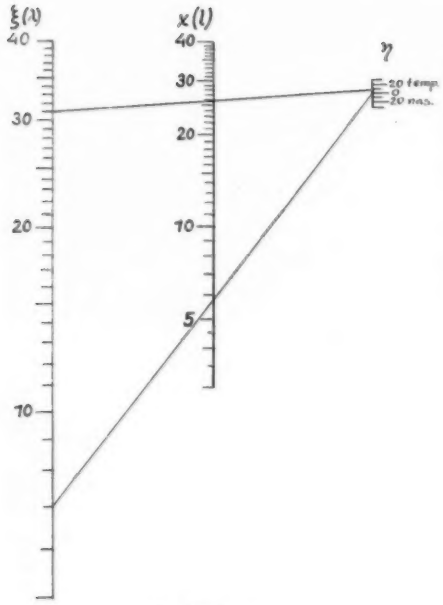

Fig. 2.

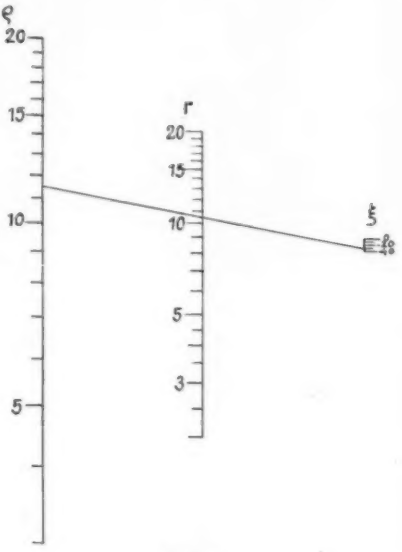

Fig. 3.

Die Gleichungen 1 a und 3 a können, wie man sieht, mittels zweier logarithmischer Fluchtliniennomogramme gelöst werden. Diese sind in den Figuren 2 und 3 dargestellt, wobei angenommen ist, dass f gleich 70 cm und f' gleich 75 cm ist, sowie dass a und a' den Wert von 60 bzw. 70 cm haben.[1] Um x und r zu erhalten, hat man also nur die Strecken ξ, η, ϱ zu messen, was am einfachsten mit Hilfe eines Messtocks aus Zelluloid geschieht, gemäss Figur 1 c, sowie im Nomogramm die gefundenen Werte mit einem Lineal zu verbinden. Dieses schneidet dann die x- bzw. r-Skala in den gesuchten Werten. Auf gleiche Art wird l aus λ berechnet, wobei zu beachten ist, dass η in diesem Fall gleich null ist, da ja die Hornhautkuppe auf der Augenachse liegt. Der Abstand des Fremdkörpers hinter der Frontalebene durch die Hornhautkuppe ist dann $x - l$.

Die erhaltenen Werte geben also die Lage zu einem vollbestimmten Punkt, nämlich der Hornhautkuppe, an. Dagegen geben sie vielleicht keine anschauliche Vorstellung davon, wie der Fremdkörper im Verhältnis zur Bulbuswand im übrigen liegt. Setzt man aber die für $x - l$ und r gefundenen Werte in das Diagramm von Figur 4 ein, kann man dadurch

[1] Vergleiche die Note auf Seite 340.

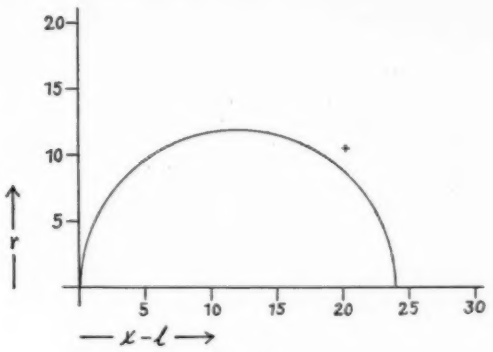

Fig. 4.

eine unmittelbare Anschauung dessen bekommen, wie der Körper im Verhältnis zu einem »Normalbulbus von 24 mm Durchmesser» liegt.

Um die Methode noch mehr zu veranschaulichen, soll ein Beispiel angeführt werden, für das die entsprechenden Sichtlinien in das Nomogramm eingezeichnet sind. In dem Fall, der durch Figur 1 anschaulich gemacht wird, wurden folgende Masse erhalten:

$\xi = 31$ mm, $\lambda = 7$ mm, $\eta = 8$ mm temporal und $\varrho = 11.5$ mm. In Nomogramm 1 erhält man hieraus $x = 26$ mm und $l = 5^3/_4$ mm, woraus sich $x - l = 20^1/_4$ mm ergibt, während man in Nomogramm 2 $r = 10.5$, mm erhält. Aus dem Diagramm in Figur 4 erkennt man, dass der entsprechende Punkt (durch ein Kreuz bezeichnet) ca. 1.5 mm ausserhalb des eingezeichneten Normalbulbus liegt.

Wie man sieht, kann die ganze Ausrechnung in ein paar Minuten erledigt werden. Ein anderer Vorteil der nomographischen Methode ist der, dass Nachlässigkeitsfehler bei der Ausrechnung leicht zu vermeiden sind. Zum Schluss soll der Vollständigkeit halber darauf hingewiesen werden. dass diese Ausrechnungsmethode natürlich die übrigen Fehlerquellen (die eigentlichen Methodenfehler) der Lokalisationsmethode nicht berücksichtigt, und dass deshalb die gefundenen Werte unter Berücksichtigung dieser Fehler zu beurteilen sind.

ZUSAMMENFASSUNG

Nach der Analyse des Fehlers, der bei Berechnung der Lage eines Fremdkörpers entsteht, wenn man den Wechsel des Vergrösserungsgrades für die verschiedenen Objektschichten vernachlässigt, wird eine nomographische Ausrechnungsmethode geboten. Diese ermöglicht rasche Ausrechnung unter Berücksichtigung des wechselnden Vergrösserungsgrads. Die Methode wird auf die von H. LARSSON angegebene Lokalisationsmethode angewandt.

SUMMARY

An analysis is presented of the errors that arise if, when calculating the position of foreign bodies, the change of the degree of magnification in the various layers of the object is left out of account. A nomographic method of calculation is described. This method permits rapid calculation with due consideration to the varying degree of magnification. It is applied to the geometrical localization method described by H. Larsson.

RÉSUMÉ

Après avoir procédé à l'analyse de l'erreur qui se produit lors du calcul de la position d'un corps étranger quand on néglige la variation du degré d'agrandissement dans les diverses couches de l'objet, l'auteur expose une méthode nomographique de calcul. Celle-ci permet un calcul rapide qui tient compte des variations du degré d'agrandissement. Il applique le dit procédé à la méthode de localisation géométrique de H. Larsson.

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FROM THE NORWEGIAN RADIUM HOSPITAL, OSLO (CHIEF: ROLF BULL ENGELSTAD, M. D.)

ON THE TREATMENT OF MALIGNANT TUMOURS OF THE TESTIS[1]

by

Haakon Ödegaard

The benign tumours in the testis are so rare that they do not play any practical rôle. Neither do the malignant tumours occur very frequently. In the ten-year period 1926—1935 they amounted in this country to only 0.3 per cent of the total deaths from cancer in men. From American sources it is stated by HIGGINS and BUCHERT that they represent 0.5 per cent of the total malignant tumours in men.

A rather considerable disagreement has prevailed respecting the classification of malignant testicular tumours. From a practical clinical standpoint they may be distributed into two main groups: 1. Seminomas. 2. Malignant embryonal testicular tumours, »teratomas». The genuine sarcoma (from the interstitial connective tissue) and the true carcinoma (from tubuli recti) are so rare that they have little significance. From Danish sources — HAMBURGER, BANG and NIELSEN — great stress is laid on the hormonal relations in the classification, it being urged that the seminoma diagnosis cannot be made histologically alone. They set up a special group, the so-called pseudo-seminomas, i. e. histological seminomas where chorion hormone, (luteinizing hormone), is found in the urine, and which belongs clinically therefore, to the »Epitelioma mixte» group, with poor prognosis. In one material there were found, out of 44 histological seminomas, two cases which had to be included in this group.

Malignant testicular tumours occur with equal frequency on both sides, and usually between the ages of 20 and 50. Out of 314 cases LEDDY and DESJARDINS found 81.8 per cent in this age group. In about 10 per cent of the cases the affected testis is stated to be ectopic.

That which makes the treatment difficult and the prognosis doubtful is the relation of the lymph node metastases. According to JAMIESON

[1] Submitted for publication, Jan. 18, 1945.

and DOBSON a distinction is made between primary lymph nodes which get lymph vessels directly from the testis, and secondary lymph nodes which receive efferent lymph vessels from the primary lymph nodes. Fig. 1. is a diagram demonstrating how these primary lymph nodes may be localized (according to injection test made on mature foetuses by JAMIESON and DOBSON). We take special note of the fact that on the right side we may find primary lymph nodes in front of the ureter on the edge of the minor pelvis, i. e. belonging to the iliac group. We have three groups of secondary lymph nodes:

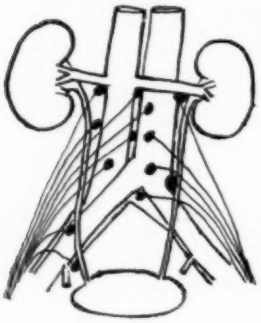


Fig. 1.

1. Lymph nodes in the primary area on the opposite side.
2. Lymph nodes behind and between the aorta and the vena cava, above and below the renal vessels.
3. Lymph nodes along the outside of the arteria iliaca communis on the same side.

According to GREVILLIUS metastases from seminomas and teratomas occur within a year in 62.5 and 92.6 per cent of the cases respectively. SHIMKIN states that in the case of »homogeneous carcinomas» it takes on an average $2\,^1/_2$ years, and of »heterogeneous teratomas» $1\,^1/_2$ years, from the onset of the symptoms until the occurence of the metastases. It is difficult, however, to detect the regionary lymph node metastases before they have become fairly large, nor is it easy to indicate exactly when the first symptoms appear. According to HIGGINS and BUCHERT supraclavicular lymph node metastases are found in 15 per cent, lung metastases in 13.8 per cent, metastases to the mediastinum in 3 per cent, metastases to the inguinal lymph nodes in 4.8 per cent, of the cases.

The usual treatment today is orchidectomy with postoperative irradiation. F. HINMAN has advocated strongly radical operation, i. e. removal of the lumbar lymph nodes on certain indications. He is of the opinion that patients with teratomas without clinically demonstrable metastases should be subjected to radical operation. He maintains that this operation is neither difficult nor dangerous. Of 100 operated cases 20 per cent proved inoperable; there was only one post-operative case of death (pneumonia). He distributes the operated cases into 3 subdivisions:

A. Those which prove inoperable.
B. The extirpated lymph nodes demonstrate no metastases.
C. The extirpated lymph nodes demonstrate metastases.

Out of 24 cases of teratoma belonging to group C, 6 survive, 2 of whom for more than 5 years; whilst out of 17 cases of teratoma belonging to group B, 6 are known to have survived for more than 5 years. As a matter of fact it is often difficult to appraise and compare the results of the different treatments. The figures are often small, the period of observation short and the pathological anatomical diagnosis heterogeneous. The same is true also of the roentgen treatment with respect both to area and dosage; sometimes it is only mentioned as roentgen treatment.

It seems to be clear, however, from the various follow-up examinations published, that roentgen treatment of teratomas does not prolong life. On the other hand it is beyond doubt that roentgen treatment of seminomas prolongs life.

Table 1

Number of cases and percentage of survivors of seminomas, with corresponding figures for teratomas in brackets.

	3 years		5 years		10 years	
CABOT and BERKSON	Number	%	Number	%	Number	%
With roentgen...	50 (31)	80 (29)	45 (29)	71 (24)	23 (19)	48 (26.3)
Without roentgen	19 (12)	68.4 (41.7)	17 (12)	58.8 (41.7)	15 (11)	46.7 (27.3)
	4 years					
GREVILLIUS	Number	%				
With roentgen ...	39 (13)	59 (15)				
Without roentgen	49 (34)	59 (35)				

If at the time of the orchidectomy lymph node metastases have not developed, it probably does not signify whether the patient receives roentgen therapy or not. In case of incipient spread to regional lymph nodes, one may perhaps have hope of destroying these metastases. If, on the other hand, the seminoma metastases have become clinically demonstrable, it is in reality very extensive, as regards both size and area, and even if it is possible by palpation to perceive their reduction or even disappearance, one must count only on a temporary improvement. R. T. PAYNE finds that out of 38 malignant testicular tumours (14 of which treated postoperatively with irradiation) none of the 15 survivors in the five-year period had any demonstrable metastases at the commencement of the treatment. Even in case of massive seminoma metastases, however CABOT and BERKSON found that 6 out of 12 survived after the five-year period. For the teratomas, the corresponding figures were 2 out of 13 (orchidectomy+postoperative irradiation).

In a material of 314 malignant testicular tumours from the Mayo Clinic, LEDDY and DESJARDINS demonstrate that the best results are obtained when both orchidectomy and subsequent irradiation have been effected at the clinic. Of the 64 cases subjected to follow-up examination, 53 per cent survived for 5 years. The majority received treatment on four anterior fields from the xiphoid process to the pubic bone, together with the corresponding posterior fields. Similar fields have also been indicated from a Danish source, JENS NIELSEN. The anterior fields, however, extend here only to some 6 cm. below the umbilicus, and do not include the iliac fossa.

At the Norwegian Radium Hospital 37 cases of malignant testicular tumours have been treated from 1935 up to and including 1941. Of these 21 were seminomas and 16 malignant embryonal mixed tumours (teratomas). With regard to the teratomas no biopsy was obtained in 2 cases, for which reason the diagnosis here was uncertain. The age distribution appears from table 2.

Table 2

	0—9	10—19	20—29	30—39	40—49	50—59	60—69	70—79
21 cases of seminoma	0	0	2	7	9	2	1	0
16 cases of teratoma	1	0	3	7	3	0	1	1

The oldest patient was 71 years of age, the youngest (teratoma) 1 1/2 years. 26 of the patients, i. e. 70 per cent, were between 30 and 50 years. In 19 cases the right and in 18 cases the left testis was affected. Previous traumas were indicated for the seminomas in 5 cases, and for the teratomas in 2 cases. Tumour development in undescended testis occurred with respect to the seminomas in 2 cases, and to the teratomas in 1 case. The Aschheim-Zondek reaction was carried out in 14 patients with seminomas, all with negative result, and in 11 patients with teratomas, one of which with positive result. It was found that the reaction was not of any prognostic value.

The symptoms observed by the patients themselves appear from table 3.

Table 3

	Growing testis	Hard testis	Painful testis
21 cases of seminoma.....	14	6	6
16 cases of teratoma.....	14	8	6

In 3 cases of both categories it has been particularly stated that no pain had been felt. In one case haemoptysis, due to lung metastases (seminoma), and in another case ascites (teratoma), was the symptom which brought the patient to the physician. With regard to the semi-

nomas, it has been stated twice that the testis, in which the tumour developed later, had always been larger than the other.

The duration of the symptoms prior to admission into hospital appears from table 4.

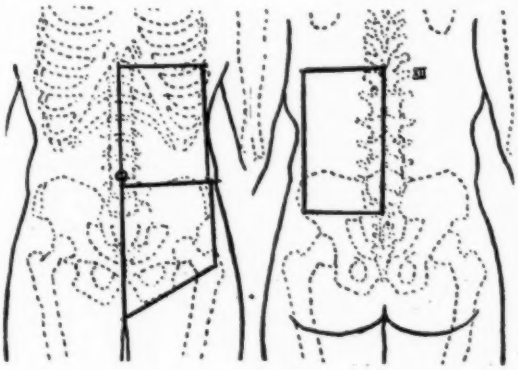
Table 4

	0—½ year	½—1 year	1—2 years	2—3 years	3—4 years
21 cases of seminoma	9	8	3	1	0
16 cases of teratoma	11	1	1	2	1

34 of these 37 patients had been operated on before admission, whilst 3 were inoperable. In one case the operation had taken place 13 months before admission. With regard to the remaining patients operated on, it was a matter of a few weeks' interval. Nature of the operation:

Orchidectomy only: 32 cases.
Orchidectomy+removal of inguinal lymph nodes: 1 case.
Orchidectomy+removal of lumbar lymph nodes (radical operation): 1 case.

As regards the latter case it related to a teratoma in which regional lymph node metastases was disclosed at the operation. Apart from these there were on admission demonstrable metastases: in 4 cases of semi-



a. b.

Fig. 4.

noma, with possible metastases in one case, and in 8 cases of teratoma. It should be noted particularly that in 4 cases there were palpable filling in the iliac fossa; in the groin suspected lymph nodes were present in 2 cases.

At the Norwegian Radium Hospital the patients receive roentgen treatment on 3 fields (BULL ENGELSTAD): one iliac field, one field to-

wards the lumbar region from the front, and one, a little larger, towards the lumbar region from the rear (fig. 2). Irradiation is performed 6 days in the week, with one field per day. Daily dose as a rule 350 r with 175 Kv, 4 Ma. and 50 cm. distance. Now a filter is used consisting of 0.85 Cu+0.5 Al. Intensity: About 13 r/min. Effort is made to reach a dose of 3500 r in each field. In the first years the dose was usually a little less: 2000—3000 r. The period of treatment is generally from 5—6 weeks. Care is taken to cover the other testis during the irradiation, and 2 of the patients have become fathers 3 and 4 years after the termination of the roentgen treatment.

Of the seminomas one has been treated with total irradiation, as there was lung metastases, whilst another has received roentgen treatment, solaminis causae, on a large ulcerated, inoperable tumour. There remain 19 cases which were treated adequately. 2 of these had definite clinical glandular metastases at the beginning of the treatment (large abdominal tumour, lymph nodes in the iliac fossa), whilst 4 have since come in for treatment for metastases with the following localization: the supraclavicular fossa: 2 cases, Groin: 1 case, Supraclavicular fossa and the mediastinum: 1 case. The result of the treatment with respect to these 19 cases appears from table 5.

Table 5

Irradiated	Survived without recurrence: 11 cases			Died: 8 cases	
	2 years	3 years	Over 5 years	From metastases	From other causes after 2 years freedom from recurrence
19	11	8	2	6	2

None of the survivors had demonstrable metastases when the irradiation commenced, but one of these during a later stay received teleradium therapy on the suspicion of a supraclavicular lymph node, the size of an egg, which disappeared as a result of the treatment, and the patient was free from recurrence 2 ½ years after the last treatment.

With regard to the 16 cases of teratomas 2 were not irradiated, and 1 only inadequately, due to extensive metastases, and these 3 patients have since died from their lesion 2—8 and 15 months after admission, and 3, 1 and 4 years after the onset of the symptoms respectively. The one who lived longest had the whole time demonstrable ascites. The result with respect to the 13 cases who must be said to have had adequate irradiation treatment appears from table 6.

Table 6

Treated	Survived free from recurrence after treatment: 4		Died: 9.
	2 years	3 years	Of metastases
13	4	3	9

The nine fatal cases died within 2—23 months after admission due to metastases, and from 7—28 months after the onset of the symptoms. One of the 4 survivors was before admission subjected to radical operation with demonstration of lymph node metastases, and lived free from recurrence $3\,^1/_2$ years after. The interval between the onset of the symptoms and the operation was 12 months for this patient. In the others, one of whom was $1\,^1/_2$ years old, no clinical sign of metastases was found at the beginning of the treatment.

SUMMARY

37 cases of malignant testis tumours — 21 seminomas and 16 teratomas — have been treated at the Norwegian Radium Hospital in the period 1935—41. Of these 19 and 13 respectively have received adequately postoperative irradiation. Of the seminomas 11 survived free from recurrence for 2 years or more, 8 of whom for 3 years or more, whilst 2 have lived for more than 5 years. Of the teratomas 4 lived free from recurrence for 2 years or more, 3 of whom for 3 years or more. Prior to the irradiation one of the survivors in the 3 years-period of the teratomas was subjected to radical operation(Hinman's operation), and lymph node metastases were then demonstrated.

ZUSAMMENFASSUNG

37 Fälle von malignem Hodentumor — 21 Seminome und 16 Teratome — wurden in der Zeitspanne 1935—1941 im Norwegischen Radiumkrankenhause behandelt. Von ihnen bekamen 19 bzw. 13 die gebräuchliche postoperative Bestrahlung. Von den Seminomen überlebten 11 rezidivfrei 2 Jahre oder mehr, darunter 8 Fälle 3 Jahre oder mehr, während 2 mehr als 5 Jahre lebten. Von den Teratomen lebten 4 Fälle 2 Jahre oder mehr ohne Rezidiv, 3 von ihnen 3 Jahre oder mehr. Vor der Bestrahlung war an einem der Teratome, die 3 Jahre überlebten, eine Radikaloperation (Hinmans Operation) vorgenommen worden, wobei Lymphdrüsenmetastasen nachgewiesen wurden.

RÉSUMÉ

L'auteur rend compte de 37 cas de tumeurs malignes du testicule — 21 séminomes et 16 tératomes — traités à l'Hôpital Norvégien du Radium dans les anneés 1935—41. 19 des premiers et 13 des seconds ont été soumis à l'irradiation postopératoire usuelle. 11 des malades atteints de séminome ont survécu 2 ans ou plus sans récidives; 8 de ceux-ci ont survécu trois ans ou plus et 2 5 ans ou plus. Des malades atteints de tératome 4 ont survécu sans récidive deux ans ou plus; trois de ceux-ci 3 ans ou plus.

Parmi les malades qui ont survécu 3 ans, l'un des porteurs de tératome subit avant l'irradiation l'opération radicale (opération de Hinman) qui permit de démontrer l'existence de métastases dans les ganglions lymphatiques.

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FROM THE RADIUM CENTER, COPENHAGEN (CHIEF: JENS NIELSEN, M. D.)

INTENSITY VARIATIONS IN THE FIELD OF IRRADIATION[1]

by

Viggo E. Thayssen

When we speak of the intensity of a field, we generally mean thereby the amount of radiation that at a certain distance and with a given half value layer is measured in its central ray. But the dose is not the same in the central portions and in the periphery; because the distance from the focus is different, and because the intensity decreases with the square of the distance according to the formula $\frac{a^2}{a^2+r^2}$, in which a is the field-to-focus distance, r the distance from the center of the field to the periphery. In practice, also other factors are found to play a rôle, so that this theoretical optimum cannot be reached, even by far. It is not my intention with this little study to enter into an analysis of these purely physical questions, which will only be touched upon, but to show by a couple of examples how the intensity in the daily, practical work is distributed in a cross-section of the beam.

In the literature there are only few evidences of interest in this question; at least there are only few studies of the subject from recent years, despite the great development that has taken place both in the roentgen tubes and the technique of mensuration. ZUPPINGER has during biologic experiments with ascaris eggs measured the surface dose on a field 10.6×10.6 cm. at a distance of 25 cm. The measuring was done with a Coolidge therapy-tube, with 100 kv., 6 ma. and cardboard filter. He found that in the corners of his field, where the calculated intensity should be 92.7 per cent, the values varied not a little, — from 80 to 92 per cent of the intensity in the center. In a central square of the field 5.5×5.5 cm., he found 100 per cent homogeneous intensity. He also mentions that the values in the anode end of the field are a little lower than in the opposite; and he suggests as explanation of this that the anode metal

[1] Submitted for publication, Sept. 14, 1944.

probably shadows a little, and that the lesser yield there may perhaps also be due to depressions in the focal spot. HOLTHUSEN mentions an isodose curve for surface dose, by DORNEICH, measured at 40 cm.'s distance with filter 0.5 mm. Cu.+ 2 mm. Al., and 165 kv. There is nothing stated about measuring technique or type of tube, but the measuring was probably done photometrically. The curve shows that at 13 cm.'s distance from the center only about 62 per cent of the intensity at the center is obtained, as against an expected 90 per cent. DEN HOED briefly mentions the irregular distribution sometimes observed in the intensity in the field, of which he supposes that it may be due to the tube not being centered in relation to the hood; and he also points out that the distribution is different with the different types of tube. ZINTHEO has described the distribution of the intensity in a cross-section of the beam from diagnostic tubes (Metalix, among others) with linear focus of 2.6 and 2.9 mm., measured at distances of 25 and 50 cm., with 60 kv. With unfiltered radiation he finds that the maximum does not lie centrally in the beam, but about 8 degrees off the center, towards the cathode end of the tube, while the hardest radiation lies slightly off-focus towards the anode end. With filter of 5 mm. Al., the displacement of the maximum is slight, however. ZINTHEO does not give any isodose curves, but he states that the radiation becomes considerably feebler towards the periphery. Thus, he mentions that the use of a plane filter will reduce the peripheral radiation owing to the more oblique projection of the rays through the latter. This will be the case to a still higher degree in the case of close irradiation with very soft rays. HASCHÉ mentions the distribution in a field 1.5 cm. in diameter and with focus-to-skin distance also of 1.5 cm., and notes a fall in the intensity, from center to periphery, from 100 per cent to 32 per cent. These figures must not, however, be directly compared with the measurements of ordinary therapeutic radiation; for in close irradiation the focal spot is of about the same size as the irradiated object, and therefore gives a distribution of the intensity very nearly the same as with radium. ZUPPINGER and ZINTHEO used for their measurements dosimeters of the »thimble» type, whereas HASCHÉ, and probably DORNEICH, measured photometrically. Thimble-dosimetry is not particulary exact, but very easy to perform; whereas photometric measurement gives greater exactitude, but is too complicated for practical use. It was therefore a great step in advance when SIEVERT and others introduced a modified »thimble chamber»; but a really useful device was not obtained until SIEVERT in 1932 constructed his small, spherical condenser chamber.

The following measurements were made with such small condenser chambers (condiometer, ext. diam. 10 mm.), built on SIEVERT's principle

and with a capacity of 7 *r*. The technique of measuring was as follows. Over a wooden frame, 25×25 cm. inside measurement, was stretched a washed roentgen film. On this was traced a suitable system of dividing lines, and along these the condenser chambers were placed in such manner that the entire beam of the tube was mapped out. The frame was mounted about 50 cm. above the floor on an ordinary laboratory stand and adjusted horizontally by means of a spirit level. After the tube had been brought into perpendicular position, the frame was centered underneath it; the tube was removed, and when the condenser chambers had been placed in position the distance was adjusted. All the measurements were made at a distance of 40 cm., reckoned to the center of the chambers, without tube and with use of our ordinary irradiation factors: 180 kv., 6 ma. and filter 0.5 Cu. Six separate measurements were made for the plotting of each isodose curve, and the irradiation time varied less than 0.2 seconds. With exception of the slender stand in which the frame was fastened, there was nothing within 50 cm. from the latter which could cause backscatter; though, according to KUESTNER, 20 cm. of free air should be sufficient to ensure against disturbance from that source. The tubes, — SIEMENS DOW 230/6 and 230/15, in »tutohaube», — showed an even decrease in intensity towards the periphery of the field; though in the manner that the rate of the decrease increased with increasing distance from the middle. By adding up the isodoses from five tubes, we got a curve (Fig. 1) very nearly corresponding to the one given by DORNEICH, who 9.5 and 13 cm. from the center found intensity values of respectively 78 and 62 per cent, corresponding to the Doglas tubes at the same distance giving 82 and 65 per cent. Like DORNEICH, we also found slightly elliptic curves with the longest axis parallel to the longitudinal axis of the tube. The slight decrease in intensity at the anode end, mentioned by ZUPPINGER, must no doubt have been due to his having used very soft rays; about which radiation also ZINTHEO says that its maximum lies slightly off-center, in direction of the cathode end of the tube. ZINTHEO found that with the use of only 5 mm. Al. the displacement was corrected, which accords well with the measurements

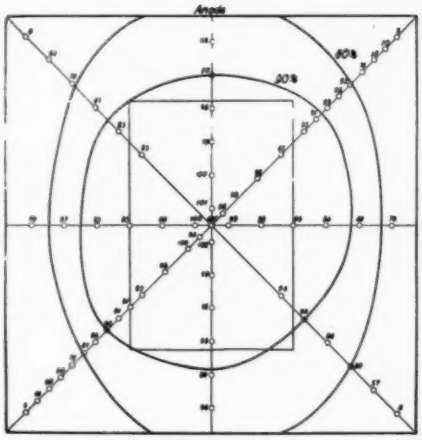


Fig. 1.

given above. In practice, there is thus a quite considerable decrease in the intensity from the center to the periphery, — somewhat varying for the different types of tube. For DOW 230/6, the decrease should at a distance of 8 cm. from the center theoretically be 5 per cent, but is found to be 10 per cent, and at a distance of 10 cm. the theoretical and actual figures are respectively 7 and 20 per cent. It is impossible to give a fully sufficient physical explanation of the different factors contributing to the weakening of the peripheral radiation, but it seems clear

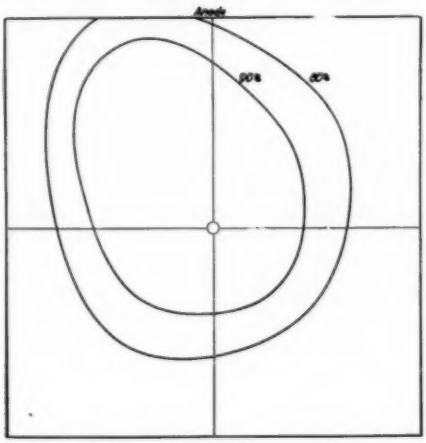


Fig. 2.

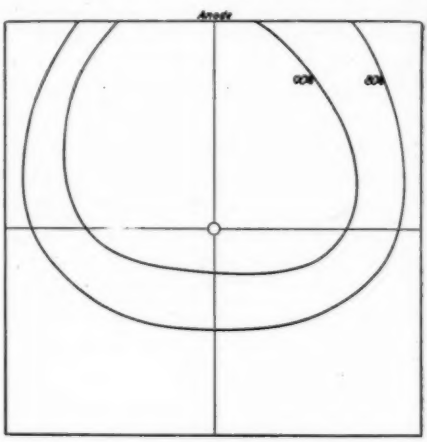
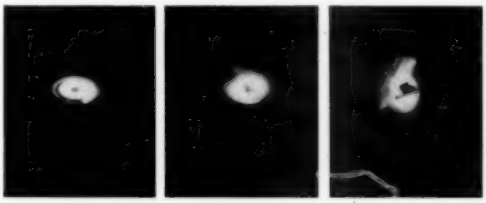


Fig. 3.

that the border about the beryllium window, the hood of the tube and the material it is made of, together with the matter of filter (whether a flat or a curved is used) must have an influence in this respect.

A systematic measuring of our 11 tubes at the Radium Center showed that two of them, nos. V and XII, deviated considerably from the average curve mentioned above. As it will be seen from Figs. 2 and 3, there is in them both a considerable displacement of the maximum of intensity towards the anode end of the tube. Common for them both is also that they have had a very long life (over 12,000 hours' functioning). Measuring with KUESTNER's dosimeter showed that the output of no. XII, measured with 0.5 Cu. at 40 cm. distance, had decreased somewhat, from 29 *r*/min. to 24 *r*/min. For no. V, similar measuring showed no demonstrable decrease, though; probably because the range of the KUESTNER dosimeter does not extend beyond a small central field. The curious isodose curves can hardly be due to the tube having been badly centered in the hood; because photographs taken with the use of a pin

hole camera show that though the focus gives an abnormal picture the centering in relation to the hood does not seem to be affected. Nor yet is it probable that the measuring arrangement should not have been properly centered; since the same changes repeated themselves at several measurements independent of one another. If the photographs taken with a pin hole camera, with tubes V and XII (Figs. 4 b and c), are compared with the corresponding isodose curves, it will be seen that they give a very good impression of the asymmetric radiation. In the reports of the Danish Radiologic Society for 1943, WISSENBERG mentions a couple of cases of burned-out roentgen tubes of the same type as those here described, in which the wolfram anode had become completely detached from the copper block that held it. (A similar case is mentioned by



a. b. c.

Fig. 4.

HASCHÉ.) Unfortunately we had not then made any measurements on the field beforehand; but as pictures taken with a pin hole camera at that time and those taken now resemble each other, it is possible that the abnormal isodose curves are due to beginning detachment of the anode. It is not unreasonable to suppose that such a detachment may be due to a difference in the expansion-coefficient of the two metals, and that the many heatings and coolings (moreover, as regards the two metals wolfram and copper, to different degrees of temperature), in connexion with the perhaps less effective cooling in tubes that have been in use for a long time, may have been a contributing cause. It must also be remembered that in tubes that are much used the filament undergoes changes which alter its capacity for emission, so that certain parts of it send out particularly many or particularly few electrons. This will result in unequal heating of the wolfram plate, greater in some places, lesser in others, which may perhaps result in its becoming a little loosened from the copper block. And thus the way is opened for further changes, because now also the dissipation of the heat is comprised. That the emission from the filament even under normal conditions is not quite even is seen by the fact that even with new tubes it will never, on photographing

with a pin hole camera, be possible to get a picture of the focus showing a uniform, even surface; it will always appear as an unevenly illuminated figure with regular contour (Fig. 4 a). The rarefaction in the center is due to the fact that the central beginning of the filament spiral owing to the fastening becomes cooled off so much that its capacity for emission of electrons is considerably reduced. The irregularities and small depressions that always appear in the focal spot during the use of the tube were in the cases mentioned by WISSENBERG very moderate; and it must therefore be supposed that it was not a question of overcharging of the tube, with resulting enormous changes, such as those described by LIECHTI.

During the daily therapeutic work it must thus be remembered that the distribution of the intensity differs somewhat for the different types of tube, and that it in the peripheral parts of the field is reduced so much that the use of large fields must be a matter for careful consideration, since the intensity here in some parts of the periphery of the field is less than 50 per cent of the intensity in the center. This becomes of importance especially in tangential irradiation of the breast with fields of 20×24 cm., and in scientific experiments, where exact dosimetry is necessary. Total irradiation, as proposed by HOLZKNECHT, by placing several fields side by side and with the centers at a distance from each other corresponding to the focus-to-skin distance, is not possible with the tubes mentioned above; because at 40 cm. distance the 50 per cent curve lies 14 cm. from the center. Theoretically, though, the 50 per cent isodose curve lies, with this distance, 40 cm. from the center.

Especially in a smaller service, with only a single tube, the occurrence of abnormal changes in the field like those described are very troublesome. The variations in intensity are great enough to make the treatment less efficacious, and yet so small that they cannot be demonstrated by the routine dosimeter measurements on the central portions of the field. With a dosimeter of the thimble type for control of the therapy tube instead of, for instance, KUESTNER's dosimeter, it is only to a certain extent possible by measurements in the center and the periphery to demonstrate the unequal intensity. There may therefore perhaps be reason, at any rate when the question is of old tubes of long service, to adopt the easy and inexpensive method of pin hole camera photography of the focus, as a regular part of the routine control of the therapy tube, supplemented with measurements of the intensity distribution in the field.

SUMMARY

After a brief mention of the literature, the author describes the isodose curves of a Siemens tube DOW 230/6 in »tutohaube», investigated with small condenser chambers. The curves agree well with those found by DORNEICH, and show, when large fields are used, that the periphery gets less than 50 per cent of the intensity in the center. He mentions a couple of tubes that had been much in use, in which the isodoses were found to deviate considerably from the normal, and where photographs taken with a pin hole camera showed the focus to be asymmetric. He suggests that specially in the case of old tubes that have been much in use, the routine measurement of the dose should be supplemented with photography with a pin hole camera, and perhaps with measuring of the distribution of the intensity.

ZUSAMMENFASSUNG

Nach kurzer Erwähnung des Schrifttums beschreibt Verf. die isodosischen Kurven einer Siemens-Röhre DOW 230/6 in Tutohaube, mit kleinen Kondensorkammern. Die Kurven stimmen mit den von DORNEICH gefundenen gut überein und zeigen bei Verwendung grosser Felder, dass die Peripherie weniger als 50 % der im Zentrum vorliegenden Intensität erhält. Er erwähnt einige Röhren, die viel in Gebrauch gewesen waren, bei denen es sich herausstellte, dass die Isodosen von den normalen bedeutend abwichen, und bei denen mit einem Lochkamera gemachte Aufnahmen zeigten, dass der Fokus asymmetrisch war. Er schlägt vor, dass man, besonders bei alten und viel in Gebrauch gewesenen Röhren, die routinemässige Messung der Dosis mit Photographierung mit einem Lochkamera vervollständigt, und vielleicht auch mit Messung der Verteilung der Intensität.

RÉSUMÉ

Après de brèves indications bibliographiques, l'auteur décrit les courbes isodoses d'un tube Siemens DOW 230/6 muni d'une culotte »Tuto» contrôlé au moyen de cellules de condensation. Les courbes sont pareilles à celles obtenues par DORNEICH et démontrent que, lors de l'irradiation de larges surfaces, elles diminuent du 50 % à la périphérie. Il cite un couple de tubes ayant fait un long usage dont les isodoses différaient considérablement de la normale et où des photographies de trou montraient l'asymétrie du foyer. Il recommande, surtout lorsqu'on emploie de vieux tubes ayant beaucoup servi, d'ajouter à la mesure courante de la dose la photographie avec la chambre spéciale sus-nommée et peut-être aussi la mesure de la distribution d'intensité.

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FROM THE RADIUM CENTER, COPENHAGEN (CHIEF: JENS NIELSEN, M. D.)

CLINICAL RESULTS WITH ROTATION THERAPY IN CANCER OF THE ESOPHAGUS[1]

A preliminary Report based on 174 Cases

by

Jens Nielsen

The revived interest in rotation therapy has in the last few years resulted in the appearance of several studies on the subject, especially by German and Japanese authors. Most of them have dealt chiefly or exclusively with the theoretical basis for this method of treatment, and have, on the basis of calculations or experiments, discussed the possibilities for its employment in practice; very few relate personal clinical experiences with the method. Only NAKAIDZUMI & MIYAKAWA[2] briefly report their observations and the primary results obtained in 39 cases of cancer of the esophagus. In 32 of them the difficulty of deglution was lessened, in 2 the effect was uncertain, in 3 the condition grew worse, in 3 the treatment was not completed. All the cases were, at the time when the report was written, so recent that nothing could be said about the durability of the results. Only slight cutaneous reactions were observed, and, in spite of large daily and total doses, no general reactions except moderate leukopenia; nor were there any other unpleasant after-symptoms. The authors think that in some of the cases the dosage had been too high.

As it seemed reasonable to think that the rotation therapy might offer some fresh possibilities in dealing with cancer of the esophagus, which has hitherto proved little amenable to curative treatment, we have at the Radium Center gone in for this therapy to a considerable extent, and the following will chiefly be an account of the results obtained with the method in the past three years. Of course, some time must elapse before it is possible to evaluate with certainty the results of a modification of any cancer therapy. Still, the clinical development of carcinoma of

[1] Submitted for publication, Sept. 14, 1944.

[2] Strahlentherapie, *68*, 254, 1940.

the esophagus, the most malignant and most rapidly lethal form and site of epithelial cancer, has hitherto been so quickly fatal that it is permissible already after a relatively short observation time to draw certain conclusions with regard to the therapeutic effect. As, moreover, our material is comparatively large and our experience fairly thorough with regard to what could be obtained with the earlier forms of radiation treatment in these cases, I believe that we may be justified in presenting, already now, our clinical results, so far, with the new therapy. To give an idea of how the treatment is tolerated, I shall add to the account of these a description of the reactions and complications observed and a discussion of our experiences with regard to such matters as the magnitude of daily and total dosages and their best distribution in time. In a manner of introduction, I first briefly sum up the results of our experimental mensurations.

Experimental Studies, and the Lines for the Treatment based on these

The measurements on phantoms show that by centric rotatory irradiation of cylindric objects bell-shaped intensity curves with a high and approximatively homogeneous dosis area may be obtained about the axis of rotation corresponding to the axial field, surrounded by a peripheral zone of much lower, but likewise fairly homogeneous intensity. Under favorable conditions, the ratio of the intensities in these areas may be as 3, 4 or 5 to 1, and the descent of the intensity curve from the axial field to the peripheral zone rather steep. As said in our previous reports,[1] centric rotatory irradiation may within certain limits be characterised by the ratio of skin dose to axis dose, — what, for the sake of convenience, may be called: the d e g r e e o f e f f e c t. With a few exceptions of no significance in practice, our measurements have shown that the most favorable degree of effect is obtained when the focus-skin distance and the half layer value are as great as possible, the size of the field and the object, and the density of the latter, as small as possible. With cylindroid or flattened phantoms, the degree of effect is poorer in the short axis than in the long.

In the choice of the filtration and the focus-axis distance, practical conditions must be considered. The measurements have shown that comparatively little is gained in degree of effect by using half layer values of more than 0.9 mm. Cu. and focus-axis distances greater than 50 cm. In the treatment of patients we have therefore chosen to operate with these two factors. By using 180 kv., 0.5 mm. Cu. and 15 ma. the intensity, measured in air, is 65 r/min. at a distance of 40 cm., 42 r/min. at

[1] JENS NIELSEN & HOEFFER JENSEN, Acta Radiol. *23*, 51, 1942; HOEFFER JENSEN, JENS NIELSEN & V. THAYSSEN, same, *25*, 95, 1944.

a distance of 50 cm. Each sitting can thus be given in reasonably short time (10—15 minutes). (Besides Siemens' »Tutohaube» we have used the roentgen »bomb», the latter with 200 kv. and 30 ma.) In the first two years we made use of considerably softer radiation (half layer value 0.3 mm. Cu.), but in the last year or so we have used only the harder radiation stated above, which increases the degree of effect so that the same tumor dose can be obtained with a lesser volume dose.

The size of the axial field is fixed by the extent of the tumor. It is evident that carcinoma of the esophagus must lend itself particularly well to rotation therapy, owing to the almost central location of the esophagus in the longitudinal axis of the thorax; and because the extent of the esophageal tumor is greatest in the same direction, in which also any eventual lymphatic metastasing of it will chiefly occur.

To get the full use of the rotation therapy it is necessary to work with the narrowest possible field, and here the screening control becomes of the greatest importance; for our experiments have shown that when narrow fields are used slight deviations from the exact centering may result in calamitous changes in the intensity distribution. But though we have always aimed at using fields as small as possible, we have at the same time taken care that the axial field should be wide enough to cover the whole breadth of the tumor, so that the latter became irradiated homogeneously. This can, as a rule, be ensured by using an axial field 4—5 cm. wide, sometimes even with a smaller (3 cm.).

The size of the object is given by the circumference of the patient's thorax. Also in rotation therapy the irradiated volume, — or, in other words, the distance of the tumor from the surface, — is a factor of primary importance. Therefore, patients with small and narrow chests offer better prospects for a good result of the treatment than large and deep-chested. But the rotatory treatment will always have an essential advantage over cross-fire irradiation through fixed fields by increasing the depth dose, rendering the focal dose homogeneous and eliminating the risk of over-crossing effects. On the basis of intraesophageal dosimetric measurements we have in a previous article shown how the tumor dose depends on the circumference of the thorax; in the following I shall come back once more to this question.

The degree of the effect has been found to depend in a very great measure on the specific gravity of the object. Owing to the greatly varying density in the thorax, especially due to the air-filled lungs, the results of measurements on homogeneous phantoms can only with great reservations be applied directly to practical work on patients. We have before made measurements on a thorax phantom, in which the different density of the thoracic organs was reckoned with; but the only means by which the actual dose in the individual case

can be ascertained is by measuring it directly in the esophagus, — as we also have done in a number of cases.

That the degree of effect in a flattened phantom, as already said, is poorer in the short axis than in the long means that the skin is taxed somewhat more on the anterior and posterior surfaces of the thorax than in the axillary regions; as will usually be seen also from the different strength of the reactions in these places.

The Apparatus and the practical Conduct of the Treatment

Like NAKAIDZUMI & MIYAKAWA, we have carried out our rotatory irradiation treatments of cancers of the esophagus under constant screening control. Both experimental studies and practical experience have convinced us of the great importance of this; we consider it, in fact, as an absolutely indispensable condition for a favorable result of the treatment. With fields so narrow that the volume dose despite a very considerable tumor dose is kept within moderate limits, it is only by screening that one can make absolutely sure that the beam is really centered on the esophagus during the whole of the rotation.

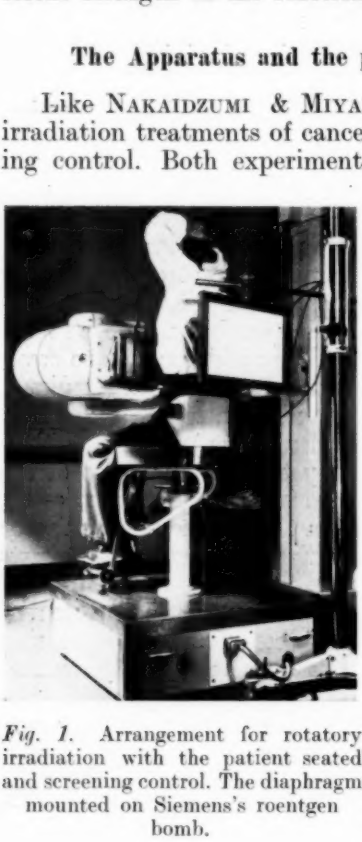


Fig. 1. Arrangement for rotatory irradiation with the patient seated and screening control. The diaphragm mounted on Siemens's roentgen bomb.

The screening control requires that the patient shall be seated on a stool which during the irradiation rotates about a vertical axis, while the roentgen tube is in a fixed position with the central ray directed horizontally; — which is also the simplest and easiest arrangement. The whole primitive technical installation can be made by simple means and at very small cost. Our stool, which is rotated by a direct-current motor, is arranged in such a manner that the time for a complete rotation can be varied continuously from a couple of minutes to half an hour. The rotation time is usually 10—15 minutes. Experience has shown that most patients tolerate this »sitting treatment» well; only with the most enfeebled has it not been possible to carry it through. There is no need for using any special back-rest or support for the arms. When the patient's arms get into the beam he is

told, through the speaking-grill, to lift them and place his hands on the top of his head. It may be well, though, to have a rope suspended from the ceiling, just above the stool, with a cross-piece which he can grasp and thus support his arms while they are lifted.

If the tumor is situated so high that the shoulders come into the beam during the rotation, it is best to interrupt the irradiation during their passage. If it extends as far up as to the level of the jugulum, one must be prepared for a much stronger cutaneous reaction on the ventral side of the thorax than on the dorsal; because the esophagus in this region lies so much nearer the ventral side that the axial field may extend all the way out to the surface. One must then guard against this, for instance by irradiating twice over the dorsal side to every once on the ventral, during the last part of the sitting. In the beginning we did not use rotatory irradiation in these high, eccentrically situated intrathoracic carcinomas; but after finding that with this precaution the method could be employed also in these cases with good primary result and without producing too strong reactions, we have included them among the forms thus treated.

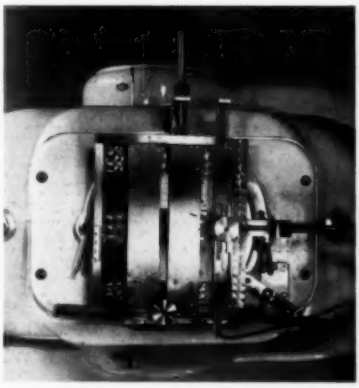


Fig. 2. The diaphragm, with the different Bowden cables for manipulation from the observation cabin.

It is advisable to guard in some manner or other against the possibility that the stool on which the patient is seated should stop rotating without it being noticed, in the dark, by the observer. We have therefore, besides the tachometer on the control-desk, a small red glimlamp fitted to the foot of the stool, as control.

As the direction of the esophagus does not quite follow the axis of the thorax, it is impossible beforehand to place the patient on the stool in such a manner that the esophagus will remain within the narrow beam during the whole of the rotation. An arrangement must therefore be made for correction of deviations during the irradiation. An adjusting device for the seat of the stool might perhaps be used for this purpose, but it is much simpler to arrange the diaphragm in such a manner that it can be displaced a few centimeters to each side by means of a Bowden cable manipulated from the observation cabin. We have also found it of advantage to be able to vary the height and width of the diaphragm-opening during the irradiation, by means of a couple of other Bowden cables likewise manipulated from the observation cabin, and

to be able from there to raise and lower the roentgen tube by means of a simple cog-lever device. By these arrangements it becomes possible to make also the first centering from the lead-protected cabin (the later ones being made by reproducing the first), and to alter the width of the diaphragm-opening during the irradiation; which is of value especially in cases of carcinomas in the lower part of the esophagus and in the cardia, where the organ turns a little more anteriorly and towards the left and is therefore projected in varying width during irradiation in different directions.

A small mouthful of barium porridge, which the patient swallows by degrees during the rotation, serves to mark the point of the stenosis, and is in most cases to be preferred to having him a swallow small leaden ball on a string, which causes greater discomfort. The barium will seldom »shadow» to any noticeable degree, since the stenosis at the beginning of the treatment usually is so considerable that only a narrow trickle will pass, and later, when the passage has become more or less re-established, there will only be question of a thin layer sticking to the mucous lining.

Of course, a rotation treatment carried out in this manner, under constant control, makes greater demands on the time of the assisting personnel than a treatment without screening; but we have found that for the most part it may safely be left to trained roentgen nurses.

It might be asked if stationary irradiation to fixed fields adjusted under screening would not serve as well as the rotatory irradiation. But to this it must be answered, firstly, that the use of fixed fields would mean the loss of one of the chief advantages of the rotatory method, namely the avoidance of beams intersecting at acute angles, with the resulting risks of local overdosage and inhomogeneous axial dose; and, secondly, the fixed fields would probably, — as it will be seen later, from the values of the daily doses employed, — require at least four or five adjustments daily, under screening control; so that very little, if anything at all, would be gained either in time or work. Moreover, it is reasonable to ascribe the slightness of the general symptoms, of which more will be said in the following, not only to the small field, but also to the very feeble reactions everywhere in the trans-irradiated normal tissue; since the single dose in the peripheral zone probably at no point reaches the threshold value necessary to elicit stronger general reactions.

It might be thought that it would be of advantage not to keep to a horizontal direction of the central ray during the rotation, but to slant the tube just a little, alternatingly upwards and downwards, and thus to make use of slightly oblique trans-irradiations in order still further to reduce the dose in the irradiated volume of normal tissue

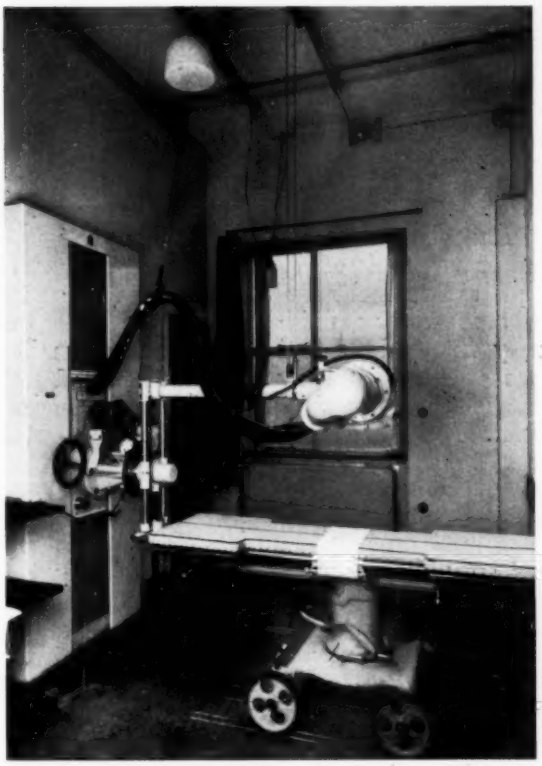


Fig. 3. Arrangement for 180° rotatory irradiation of recumbent patient.

outside the axial field. This can be done, but it tends to make the original condition more complex. The homogeneity of the axial field disappears, while the tumor dose, owing to the somewhat greater surface-to-axis distance in the oblique directions, diminishes somewhat, and the volume dose increases. As it will be shown later, we obtain by the simple rotation arrangement described a tumor dose at least two or three times as high as the dose on the skin, and we have therefore preferred for the time being to adhere to this less complicated method. The question is being studied, though, and it is not impossible that the »oblique rotation» may prove to be of value in dealing with other tumors, where the object is to trans-irradiate a larger »core» than in the case of esophagus cancers; for instance, the small pelvis in uterine cancer with parametric infiltrations.

It would carry us too far from the present subject to discuss the question of eccentric rotation. Respecting this, I may refer the reader to recent communications by WISSENBERG[1] and A. JENSEN.[2] Nor yet shall I here enter upon any description of our arrangement for rotatory irradiation of recumbent patients, with the tube rotating about a horizontal axis. The method is of less interest in connexion with the treatment of cancer of the esophagus, but is to be preferred for irradiation of uterine and rectal cancers and hypophyseal tumors. In these cases we do not use screening control, but immobilize the patient and make the adjustments on the basis of anatomical measurements and observations. The simple arrangement for this form of the treatment is shown in Fig. 3. To show the possibilities for application of the rotation principle, it may finally be mentioned that in a number of cases we have used the method, with the patient seated and under screening control, for treatment of inoperable bronchial carcinomas after induction of pneumothorax. A separate report of the results obtained in these cases will appear at an early date.

Material

Our material comprises all the referred cases from the three years 1941, 1942 and 1943. No case was refused, not even at the preliminary examination, and none has been eliminated from the material. It therefore contains a considerable proportion of severely affected and much enfeebled patients, and a number with marked cachexia and with metastases, for instance to lymph nodes in the neck, to liver, lungs and to bones. From the clinical point of view, the material is poorer than that from the preceding years, when the number of fresh cases was considerably less.[3] This is undoubtedly because also the far advanced cases, which were formerly considered as desolate and intractable and were either given bougie treatment or were taken care of at home, are now being sent to roentgen treatment in increasing numbers, as the better prospects offered by the rotation therapy are becoming more widely known among physicians and in hospital services, and the treatment of cancer of the esophagus is thus becoming centralized at the Radium Center.

As it will be seen from Table I, 194 cases of cancer of this site were referred to us in the three years. Of these, 174 (= 90 per cent) were treated by rotation therapy. Eight patients (= 4 per cent of the whole material) were already at admission so feeble that no treatment at all could be given. Twelve (= 6 per cent), in whom the cancer was situated in the

[1] Acta Radiol. *25*, 95, 1944.
[2] Ibidem, *26*, 99, 1945.
[3] see JENS NIELSEN, Acta Radiol. *21*, 352, 1940.

Table I

Site of Tumor and Form of Treatment employed in 194 Cases of Cancer of the Esophagus, 1941—1943

Site	Rotation therapy		Crossfire irradiation		No treatment	
Mouth of the Esophagus	—		—	1	—	
Cervical Portion	—	1	4	1	—	
Jugulum	6	1	5	1	—	
Jugulum to Bifurcation	10	4	—		1	1
Bifurcation	63	5	—		3	
Bifurcation to Cardia	46	7	—		3	
Cardia	6	16 7	—		—	
Fundus of Stomach	2		—		—	
Total	174		12		8	

cervical part of the esophagus (most of these were women) or at the level of the jugulum (a not uncommon site in men), were given crossfire irradiation to multiple, fixed fields. As already said, it was only after some time that we began to use rotatory irradiation also for carcinomas in the last-named site. As the Table shows, 6 such tumors were given rotatory treatment, besides 1 which also extended for some distance up into the cervical part of the esophagus, and 1 which from the jugulum extended downwards into the upper part of the thoracic portion. In the other 166 rotation-irradiated cases (= 95 per cent of the 174 thus treated), the tumor was situated entirely within the thoracic part of the esophagus. The sites are stated on the basis of the roentgenologic examination, and the location of the central point of the stenosis has been determining for the classification. In some of the cases, the location was verified (or corrected) by necropsy.

Most of the tumors were situated at the level of the bifurcation (39 per cent) or in the lower part of the esophagus (30 per cent). The cardia was involved in 18 per cent; 8 per cent were situated between the jugulum and the bifurcation; finally, 1 per cent were carcinomas of the fundus proper. There can hardly be any doubt, though, that some of the tumors rubricated as located in the cardia or in the cardia and the fundus had primarily arisen in the latter and had spread from there to the cardia; because it even by careful roentgen examination with attention directed particularly to the fundus (in erect posture with air as contrast and films of the mucosae taken with the patient recumbent, with lowered head) may be difficult to determine whether the fundus is involved or not.

Table II shows the distribution of the material according to sex and age of the patients. The average age is a little higher than in our crossfire-irradiated material of 154 cases from 1931—1938 (65.7 years, as

Table II

Distribution by Sex and Age

Age Group:	31–40	41–50	51–60	61–70	71–80	81–90	Total	Average Age
Males.....	2	4	36	56	54	3	155	65.4
Females	—	2	11	10	13	3	39	66.6

Oldest Male: 87 years. Youngest Male: 35 years.
» Female: 84 » » Female: 45 »

against 64.7). The sex incidence shows a somewhat greater preponderance of males (80 per cent, as against 73). As mentioned elsewhere (l. c.), some of the variations in the sex-incidence in the materials of the different authors are no doubt due to the rubrication of the postcricoid carcinomas. The postcricoid area is a rather common location in females, the growth often extends for a shorter or longer distance into the cervical portion of the esophagus, and the figures will always vary according to whether the tumors are classed as low hypopharyngeal or high esophageal.

Table III

Duration of the Symptoms before the Case was referred to the Radium Center.

< 1 month	1–3 months	3–6 months	6–12 months	1–2 years	Several years	Uncertain
7	73	52	34	21	2	5

Table III shows the duration of the symptoms before the patient was referred to the Radium Center. It will be seen that 40 per cent stated that their symptoms had been present for from a couple of weeks to three months, 27 per cent from 3 to 6 months, 30 per cent for at least 6 months; and that fully one-third of the latter stated that the symptoms had been present for over 1 year. Unfortunately the prospect of advances in the early diagnosis of esophagus cancer is slight.

Table IV

Degree of Deglutition Difficulty and Stenosis

	I	II	III	Uncertain
Deglutition	91	85	18	—
Stenosis	63	78	47	6

Table IV shows the degree of the deglutition difficulty and the roentgenologically estimated stenosis. We have followed HOLFELDER's method of distinguishing between 3 stages: I, soft food passes; II, only liquid food passes; III, complete stenosis.

All the patients were more or less emaciated, some of them extremely thin and dehydrated. Besides the dysphagia, half of them complained

of pains in the chest. The distribution of the tumors according to their longitudinal extent as estimated from the roentgenographs, was as follows: 3 cm., 1; 3—5 cm., 16; 5—9 cm., 74; 10 cm. and over, 67; uncertain, 36.

When first seen by us, 23 cases showed clinical or roentgenologic signs of metastases (to cervical and supraclavicular lymph nodes, 8; to hilus- and mediastinal nodes, 4; to lungs, 4; to liver, 6; to bones, 1). Necropsy reports exist with regard to 64 cases, with finding of metastases in 49 cases distributed as follows: to lymph nodes in hilus, mediastinum, cardia and intra-abdominal and supraclavicular nodes, 37 cases; to lungs, 15; to liver, 13; to bones, 4; other hematogenetic metastases, 7 cases. In 2 cases there was direct invasion of the tumor into the lung, in 7 cases direct invasion into the pericardium.

It will thus be seen that the material is by no means a particularly select one, but rather the contrary. Still, it is probably truly representative of the normal distribution of this serious disease into the different stages, such as it must be when all occurring cases are included. Most of the patients were old people, much weakened by the disease and little capable of standing intensive treatment. That it, nevertheless, only in 8 cases was necessary to abandon treatment under any form, clearly shows that the rotatory irradiation is a comparatively lenient therapy.

The roentgenologic tumor diagnosis established in all the cases was verified by microscopy in 113 (= 60 per cent). As far as possible, we tried to get the diagnosis confirmed histologically by biopsy through esophagoscope; for although the roentgenologic diagnosis may be counted on to be fairly sure, it does not give 100 per cent certainty. It may be difficult, or even impossible, from the roentgenograph alone to distinguish between a tumor and such benign esophageal stenoses as may be due to dystopic cardia, spasm, esophagitis, simple ulcer or varices. Of the microscopically examined tumors, 99 were squamocellular carcinomas, 14 adenocarcinomas. Of the latter, 13 were situated in, or involved, the cardia. Of the squamocellular carcinomas, 46 were of the epidermoid, keratinising or parakeratotic type, 27 of the mucosal type; 15 could only be characterised as base-cell carcinomas, 7 were anaplastic dedifferentiated and 4 dyskeratotic (BOWEN). This accords with our findings in an earlier study of the subject. It shows that squamocellular carcinomas of the esophagus, which constitute the great majority of carcinomas in that site, are not as highly differentiated as, for instance, carcinomas of the tongue and the oral cavity; and indicates a corresponding greater radiosensitivity. There is therefore reason to contest the not uncommon belief that nearly all carcinomas of the esophagus histologically are of a strongly keratinising squamocellular type and, consequently, radioresistant.

Ten of the patients had, besides the cancer of the esophagus, one or several primary, malignant tumors in other sites. In 6 cases, the other tumor developed some time before the carcinoma of the esophagus. These six, 4 in men and 2 in women, were cancers respectively of the skin of the face, the lower lip, the gum of the upper jaw and the tongue (this last patient was at necropsy found to have two tumors in the esophagus), the base of the tongue, the hypopharynx and the uterus. In 4 cases (3 men and 1 woman) the other malignant tumors were incidentally found at necropsy; in 1 case an esophageal tumor in another site, in 1 a cancer of the stomach, in 1 a cancer of the stomach and a fibrosarcoma of the intestine, in 1 a cancer of the prostate and a cancer of the left suprarenal gland. Of the 15 other tumors here enumerated, in 10 patients with cancer of the esophagus, 10 were situated in the alimentary tract, 7 of them in its upper portion. This involves a question which is interesting in several respects; for details of which I would refer the reader to a study by VIDEBÆK[1].

Dosage and Reactions

The problem of dosage in rotation therapy had to be worked out very largely by clinical experience, supported, of course, by experimental studies and theoretical considerations, but chiefly on the basis of the reactions observed in the patients, especially the regression of the tumor. Of course, we began with cautious single daily and total doses; which we in short time were able, however, to increase to a magnitude presumably lethal to the tumor. Since then, we have chiefly been occupied with finding the best distribution in time, of the dose, For the sake of readier survey, the gradual development of the treatment will in the following be considered only as far as strictly necessary.

A question which immediately presents itself is how to express the dosage in rotation therapy. At first we chose the entrance dose, stated as the dose measured in air 40 cm. from the focus. Thus expressed, our single doses have varied between 400 and 1,000 r, the daily doses between 400 and 2,000 r, the total doses between less than 10,000 r and 57,000 r, corresponding to a total treatment time of from 10 to 60 days.

The first 118 cases were treated with a radiation of half layer value about 0.3 mm. Cu. (180 kv., 6 ma., 2—3 mm. Al.), the last 56 with a radiation of half layer value about 0.9 mm. Cu. (180—200 kv., 15—30 ma., 0.5 mm. Cu.). Focus-axis distance in all cases, 50 cm. The width of the axial field has varied from 3 to 6 cm., the height from 5 to 18 cm. The total dose in the cases treated with soft radiation has at a medium

[1] A. VIDEBÆK, Acta Radiol. *25*, 339, 1944.

been 30,000 r, with an average treatment time of 5 weeks (29 treatment days); for the cases treated with harder rays, the corresponding values have been 20,000 r and 4 weeks (24 treatment days). The shortest time in which a treatment was carried through with presumably cancericidal dose was 18 days.

In treatment with irradiation to fixed fields it may in spite of obvious drawbacks be reasonable to use the entrance dose to the individual fields as expression for the dosage; because it often may be desirable or necessary to apply the maximum dose to the fields on the skin, and because it thus is the tolerance of the latter which sets the limit to the magnitude of the dose on each field. But in rotation therapy an expression for the amount of entering or absorbed roentgen energy received by each part of the skin cannot be found by simply measuring the intensity of the beam; and, besides, the cutaneous reaction does not here play the same rôle as in irradiation through fixed fields. In rotatory irradiation it is not a question of the focal dose becoming, at the most, of the same magnitude as the dose on the skin; it is two or three times greater than the latter; consequently, the reactions in the depth, — in the tissues within the axial field, — will be determining for the amount of radiation that the patient can tolerate. Moreover, these reactions can only be very insufficiently observed clinically, owing to the deep and difficult location of the tumor, or are, at any rate, more difficult to evaluate during the fractioned treatment than the reactions of tumors and mucosae in the pharynx and larynx, which can at least be inspected by mirror; and this makes the necessity of finding an expression for the amount of roentgen energy applied in a tumor dose doubly imperative.

As we could not be sure that the tumor dose in the esophagus could be calculated with sufficient exactitude from our measurements on phantoms, we measured it, as before said, in a number of cases during the treatment by means of small cylindric Sieverts's condenser chambers introduced into the esophagus in a thin stomach tube, at the same time as we determined the skin dose at various points of the thorax. As might be expected, the dose in the esophagus depends to a great extent on the thorax circumference of the patient, which, all other factors being equal, is determining for the tumor dose. The curve reproduced in a previous paper, which shows the dependence of the tumor dose on the circumference of the thorax for an axial field 5 cm. broad, enables us to express the given dose directly as tumor dose in the esophagus by measuring the circumference of the patient's thorax. If this dose is to be considered in relation to some other factor, it seems reasonable to consider it in relation to the dose measured in air at the focus-axis distance, 50 cm. According to this terminology, a total entrance dose of 30,000 r

through 2 mm. Al. will, with a thorax of medium circumference, be equivalent to a tumor dose of about 4,000—5,000 r, and 20,000 r through 0.5 mm. Cu. will be expression for a tumor dose of about 4,000 r.

The skin dose varies at the different points of the thorax. With the axial field 4—5 cm. wide, generally used by us, it is on the anterior and posterior surfaces 40—50 per cent, in the axillae 25—35 per cent of the central dose, which is also, as a rule, apparent from the different intensity of the cutaneous reactions in these places. The tumor dose is, in other words, 200—300 per cent of the surface dose, and there is no risk of the cutaneous reaction becoming too strong. By the end of the treatment it amounts to no more than a pigmented zone, with a dry, as a rule quite superficial, desquamation, most pronounced on the front and back of the thorax, where the zone also, on account of the geometrical conditions, is distinctly broader than in the axillae. In many cases the appearance of the skin is quite normal again already after a couple of months; sometimes the pigmentation and dryness may, however, persist for a longer time. Only in 3 of our cases did a superficial, moist epidermitis of a few days' duration occur on a circumscribed area of the front or back.

After trying different variations, we have little by little come to the conclusion that with an axial field 4—5 cm. broad the most suitable daily dosage is a tumor dose of between 100 and 200 r, usually 150—200 r, given in two sittings. This dose is by most patients tolerated without much discomfort; but at the same time we have in the matter of the individual dosage been guided very largely by clinical considerations of the patient's subjective and objective symptoms, — fatigue, anorexia, nausea, blood pressure, hematologic picture and body weight curve. The total dose, which is reached in the course of 5—6 weeks, sometimes 7—8 (minimum, 3 weeks), is about 5,000 r.

In principle, we believe, on the basis of our experience, that when the question is of squamocellular carcinomas, which on account of their comparatively slight radiosensitivity require a rather considerable amount of daily radiation, the reaction of the tumor will be all the greater the shorter the full treatment time can be made; in other words, the higher single and daily doses can be given. If the treatment is extended over too long a period, the connective-tissue reactions get time to develop, with the result that not all the cancer cells become destroyed. It should therefore be endeavored to make the treatment time as short as possible. How far it is possible to go in that respect depends on the general reactions, which are in inverse proportion to the length of the treatment time and in direct proportion to the volume dose. We have generally worked with an axial field 4—5 cm. broad, because that with a narrower field we might perhaps not obtain the homogeneous, or almost homogeneous, irradiation of the whole field of the tumor, which is one

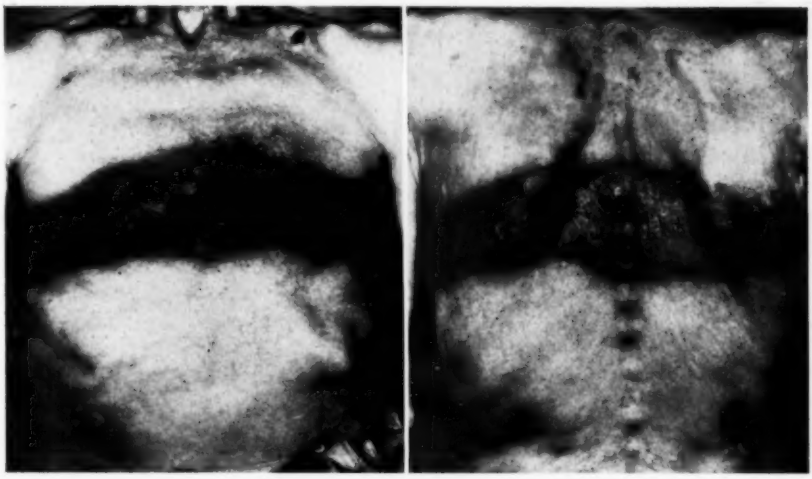
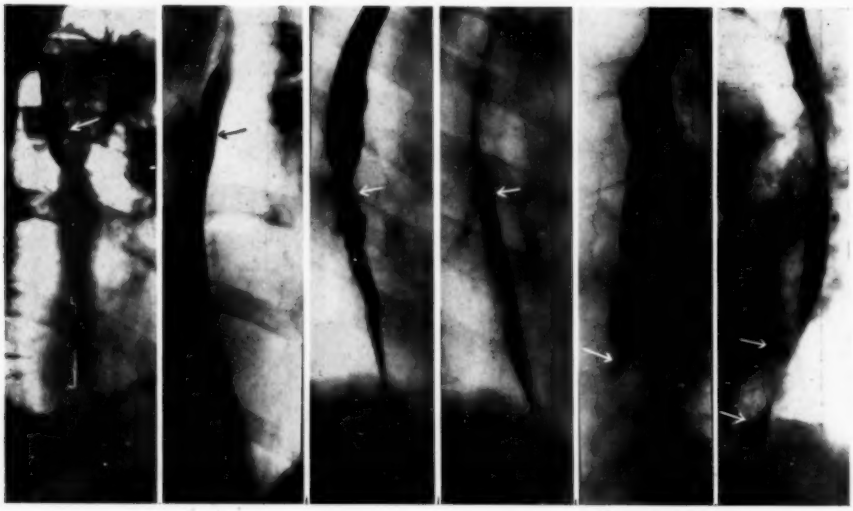


Fig. 4 a. Fig. 4 b.

Fig. 4. Cutaneous reaction at the end of rotatory irradiation treatment of cancer of the esophagus. Tumor dose, about 5,000 r (54 sittings in the course of 37 days).

of the fundamental advantages of the rotation therapy. With an axial field of this size it seems that a reduction of the treatment time to 3—4 weeks is only possible in the few cases where the patient is rather young and his whole general condition exceptionally good. In most of our cases, the treatment required over 4 weeks. If we assume that the average radiosensitivity of carcinomas of the esophagus is the same as that of pharyngeal carcinomas of medium radiosensitivity, and leave out of consideration the additional radiation which must probably be reckoned with owing to the smaller fields, the cancericidal tumor dose in the course of 4 weeks, may according to our experience, be estimated to about 4,500 r, and, if the treatment time is extended to 6 weeks, to about 5,500 r. With a slight addition on account of the smaller field, the daily tumor dose should for a 4 weeks' treatment be about 190 r, for a 6 weeks' treatment about 160 r.

These different dosage figures are, of course, given with all reservations and are only meant to serve as suggestions for the daily dosage. It is my impression that with smaller daily doses than those named there is no prospect of a curative result of the treatment, even if it is continued for a longer time (8 weeks or more). On the other hand, nothing is gained by trying with larger daily doses, which soon oblige one to interrupt the treatment, because the general reactions become too violent



a_1 a_2 b_1 b_2 c_1 c_2

Fig. 5. Showing regression of tumor after rotatory irradiation treatment. *a:* case report no. 3; *b:* case report no. 2; *c:* case report no. 1.

In some of the cases, in which we were able to carry the treatment through with higher daily and total doses than those mentioned above, the patients lost so much weight during the treatment that the loss could not be recovered afterwards, and although there was no longer any difficulty of deglutition they died in a state of debility and cachexia a few months afterwards.

Until we shall know something more about the possibilities of the periodic treatment proposed by COUTARD, we also adhere to the principle that the therapy should be carried through in one continued series, as far as possible without intervals of any considerable length between the single treatments. It might be tempting to interrupt the treatment for a time when the difficulty of deglutition has been overcome after 2—3 weeks, in order to let the patient pick up and gather strength before the sittings are resumed; but in the cases where circumstances have obliged us to make a pause in the treatment we have observed only a palliative effect.

In about twenty cases, in which the tumor in the esophagus recurred after shorter or longer time, we have given a second rotatory treatment, which in nearly all instances was tolerated well, but only rarely produced more than a brief, palliative effect.

As already said, we consider it as very important that the width of the beam should be as small as possible. We have usually worked with an axial field 4—5 cm. broad. But the height of the beam must not be too small; if it is, recurrences will set in at the upper or lower pole of the tumor.

In the practical performance of the rotatory irradiation it is a very important consideration that the large majority of the patients are old people more or less emaciated and exsiccated, and unable to support any very intense treatment. Even in the worst cases the patient's general condition can, however, as a rule be improved so much, — by copious intravenous, intrasternal or subcutaneous administration of fluids (physiologic saline, glucose- and bicarbonate solutions), blood transfusions and vitamine medications, if necessary and possible parenterally, — that the treatment can be instituted and carried through, though by no means always without interruptions.

As a rule, the difficulty of deglutition gets less in the course of a week or two, and gradually the condition improves still further. At the end of the treatment, the swallowing is in most cases normal, or nearly so. In many cases, roentgen examination after ingestion of barium porridge shows completely normal conditions, smooth passage, good mobility of the wall and natural mucosal relief with narrow folds. Primary gastrostomy was only necessary in 5 cases (= 2.5 per cent). We hold that as palliative measure this operation should in cancer of the esophagus be avoided as much and as long as possible, on account of its depressing influence on the patient.

As said, the cutaneous reactions were moderate, and it seems that the same was the case with the mucosal. In the second to third week of the treatment, at a time when the deglutition had already become considerably better, there were in a number of cases some passing complaints of a burning sensation when swallowing. With a slight, temporary reduction of the daily dose, these dysphagic symptoms, which were possibly expressions for epithelitis of the esophageal mucosa, usually disappeared in the course of a few days.

The general reactions are surprisingly slight. In spite of the large daily doses there is, as a rule, only little roentgen intoxication, if any. The cases of this kind that occurred were far less pronounced than what we know from previous years with fractioned irradiation over multiple, fixed fields, and even with small fixed fields of about 50 sq. centimeters (skin surface) and considerably smaller daily doses. Several cases could be treated ambulantly, and some patients even put on weight during the treatment. As a rule, however, the loss of weight only ceases while the treatment is in progress, and not until after its termination does the patient's weight noticeably increase. On the other hand, there is in nearly all cases

a more or less marked fall in the systolic blood pressure, which not infrequently drops to 80 or 70 mmg. Hg. According to our experience this feature is much more constant and much more pronounced in rotatory irradiation of cancer of the esophagus than in fractioned irradiation of the organs of the neck. As long as the hypotension is moderate it does not cause any discomfort. In some cases, but not always, the administration of such preparations as sympatol, oxedrin or veritol increased the blood pressure despite continued treatment; but if this medication does not help, and if the fall is marked and accompanied by fatigue and loss of weight, it is advisable to reduce the daily dose. As a rule the blood pressure gradually returns to normal values in the course of 2—3 months after the treatment.

Cardiopulmonary symptoms were rare. In a number of cases we made electrocardiographic examinations before, during and after the treatment, but could not demonstrate any changes in the electrocardiograms. Several patients with distinct, electrocardiographically demonstrated myocardiac degeneration went through the treatment without complications, only one got, a few months after, some stenocardial pains, which disappeared, however, after administration of nitroglycerin and tetranitrol. Neither did we at the necropsies find any cardiac changes that could be supposed to be due to the irradiation. Pneumonias and pulmonary fibroses due to the irradiation were observed clinically and radiographically only in 3 cases, and only in one of them of severe degree. All these patients died from recurrences of the cancer in the esophagus. At none of the numerous necropsies were any macroscopic changes due to the irradiation observed in the lungs.

Also the morphologic changes in the blood were moderate. In many cases there was a slight leukopenia, with the absolute number of white cells varying from 3,000 to 5,000 per cmm., and sometimes with moderate, relative lymphocytosis. Neither marked leukopenia nor marked anemia was observed; as a rule, the hemoglobin percentage is unaffected by the treatment. At necropsy, the bone marrow in the thoracic vertebrae and the sternum, corresponding to the zone of irradiation, was usually found transformed into fibrous, adipose marrow. In the case of a 74-year old woman, whose bones were very deficient in lime (osteomalacia), a roentgen examination 18 months after the rotatory treatment showed breakdown of a thoracic vertebra (the 9th) at the level of the irradiated zone. Roentgenologically, the picture did not resemble a metastasis in the bone, and the possibility of roentgen-osteitis can hardly be excluded. Unfortunately there is no necropsy report in the case. Such complications as hemorrhages from the tumor or perforations to the trachea, bronchi or pericardium are, according to our experience, rarer than with the crossfire irradiation formerly used.

In 7 cases there appeared in the course of the first months after the treatment, and after a period of freedom from symptoms, some signs of stenosis, which, to judge from the roentgenographs, were not due to recurrence of the tumor, but to cicatricial shrinking of the wall of the esophagus. In 4 cases, we successfully blocked out these strictures by means of bougies, and the patients are now, from 6 to 18 months after this treatment, free from symptoms. They introduce esophageal sounds from no. 30 to no. 40, themselves, every day, and the swallowing is in all cases almost entirely unimpeded. One patient had to be temporarily gastrostomised.

It must be clear from all that has been said above that it has not been my intention to minimize the seriousness of the rotatory irradiation treatment of esophagus cancer. There is no doubt that it must be considered as a considerable operation, not least in the cases of patients so enfeebled as most of those of which there is question here. But for anyone who has any experience with the crossfire treatment of these cases it is nevertheless easy to see that the rotatory treatment possesses considerable advantages over the latter; and I and my co-workers know from solidly founded experience that it in a much larger proportion of cases can be carried through with considerably less discomfort to the patient and with much fewer complications. If this were not the case, we would hardly, with all the rest of our daily work, have been able in so relatively short a time to treat nearly 200 cases of carcinoma of the esophagus by this method.

Results

It is impossible on the basis of our material to say anything definite about the ultimate results of the treatment, but the primary results are encouraging. They must be judged on the background of the extent to which it was possible to give an adequate amount of radiation. Only in 8 cases (= 5 per cent) was treatment entirely out of the question. In 34 (= 20 per cent) of the 174 cases in which a more or less intense treatment was given, it could only be considered as palliative, since the tumor dose did not reach 3,000 r; but in the other 140 (= 80 per cent) it could be said to be an attempt at an actual curative therapy, with doses approaching or reaching the lethal dose (over 3,000 r). In 44 cases, tumor doses of between 3,000 and 4,000 r were given; in 96 cases the tumor dose could be calculated to over 4,000 r.

In 117 cases, — that is in four-fifths of the fully treated and two-thirds of the total number, — complete or nearly complete primary freedom from symptoms was obtained; that is to say almost normal deglutition and, roentgenologically, marked improvement of the pas-

sage. The improvement of the deglutition was of shorter or longer duration. Recurrences in the esophagus were not infrequent; they often occurred above or below the primary stenosis, and were then accessible to another, palliative irradiation. In many cases the patient was able to swallow right up to the time of death, which in most cases was due to metastases and cachexia. The results so far show an indubitable improvement of the survival curve, which, as it will be seen from Fig. 6, shows that 25 per cent of the patients, as against formerly 10 per cent, were alive after 1 year, 15 per cent, as against formerly 4 per cent, alive after more than 2 years. The earlier material contained, however, a relatively larger proportion of the technically more easily irradiated cases in the cervical portion of the esophagus; so that a comparison, in fact, is still more in favor of the rotation therapy. The 4 per cent of the cases in the crossfire-treated material who survived for more than two years were, indeed, all high carcinomas in the cervical portion of the organ. The following few case histories will serve as illustrations of the results obtained.

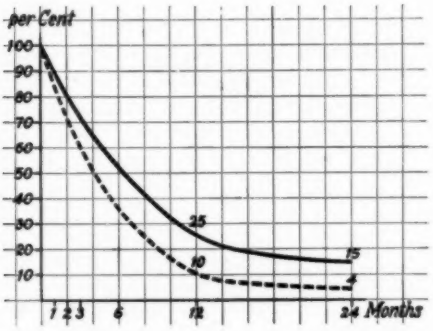


Fig. 6. Survival curves for cases of esophagus cancer treated respectively with rotatory (solid curve) and crossfire irradiation (dotted curve).

Case 1. — (No. 25800) Electrician, 62 years old, referred to the Radium Center Oct. 11th, 1941. — Dysphagia, regurgitations of mucus and loss of weight, all of 2—3 months' duration. When seen, able to swallow soft and liquid food. Strongly built, but a little thin. *Roentgen examination:* In the lower part of the esophagus, from 2 to 10 cm. above the cardia, an irregular, strong stenosis with arroded contours; the lumen barely 1 cm. wide (Fig. 5c). Esophagoscopy showed a lumpy tumor tissue, biopsy carcinoma of Bowen type. *Rotatory irradiation treatment* was given, Oct. 13th—31st, (the man remaining an out-patient the while): filter, 2 mm. Al.; total dose (entrance dose at 40 cm. distance), 30,650 r in 17 (19) days. Tumor dose, 4,200 r. Daily dose, $2 \times 1{,}000$ r; on two days only $1 \times 1{,}000$ r, however, and one day only 650 r. Strong erythema on front and back of the thorax, later succeeded by superficial, dry desquamation. The patient tolerated the treatment extremely well, there was no fatigue, he even stated that he »rather felt it to have an invigorating effect». At the end of the treatment he was able to swallow all kinds of food. Roentgen examination 3 months later showed that the stenosis had entirely disappeared, leaving no traces. The contours of the esophagus were smooth and sharp, the passage quite normal. The skin on the thorax was natural, without pigmentation. The patient has since been free from symptoms, has attended fully to his work and has gained considerably in weight. He was last seen 25 months after the treatment.

Epicrisis. — Stenosing cancer, verified by microscopy, in the distal third of the esophagus of a man 62 years old. After rotatory irradiation treatment (ambulant) complete regression, deglutition free, full working capacity, increase of weight. Until now freedom from symptoms for over 2 years.

Case 2. — (No. 26450) Workingman, 66 years old, referred to the Radium Center Dec. 29th, 1941. For about 2 months past, difficult deglutition, pain behind the sternum and loss of weight. When seen only able to swallow soft and liquid food. Rather emaciated. *Roentgen examination* showed a filling defect extending from the level of the bifurcation downwards for about 5—6 cm. The tumor did not seem to be entirely circular (Fig. 5b). At esophagoscopy there was encountered, 27 cm. from the dental margin, a projecting, ulcerated tumor, arising from the anterior and left lateral wall. Biopsy showed planocellular carcinoma of the mucosal type. Rotatory irradiation treatment was given from Jan. 3rd to Feb. 7th, 1942: filter, 2 mm. Al.; total dose (entrance dose at 40 cm. distance), 28,800 r in 15 (18) days; tumor dose, 4,300 r; daily dose, $2 \times 1{,}000$ r. As the blood pressure after this had fallen from 125/85 mm. to 90/75 mm., and the patient complained of increasing pain behind the sternum, the treatment was interrupted. The deglutition had by that time become normal. An electrocardiogram showed, with exception of bradycardia (60), nothing surely abnormal. In the course of ten days or so, the pain in the chest ceased, and a few supplementary doses, $3 \times 1{,}000$, were given in the course of 3 days. The patient has since been able to swallow all kinds of food. Already at the end of the treatment, a roentgen examination showed complete regression of the tumor, the passage during the screening perfectly natural, and in the roentgenographs no demonstrable signs of stenosis or filling defects. The patient has put on some weight. At times he has some stenocardial pains, against which nitroglycerin and tetranitrol tablets have proved of good effect. Repeated electrocardiograms showed in the first two months nothing abnormal, but later signs were found of incipient myocardiac degeneration, in the form of almost isoelectric T waves. Blood pressure normal (120/80 mm). The patient was last seen 26 months after the treatment.

Epicrisis. — Stenosing cancer, verified by microscopy, in the middle third of the esophagus of a man 66 years old. Complete regression of the tumor after a series of rotatory irradiations. The treatment caused fall in the blood pressure and seemed to elicit bradycardia and stenocardial pains, which persist with periodic intermission. Not until two years afterwards were electrocardiographic signs of incipient myocardiac degeneration demonstrated. The patient has now been symptom-free for 2 years.

Case 3. — (No. 25404) Butcher, 63 years old, referred to the Radium Center Aug. 25th, 1941. Deglution difficult for 3 months past; had in that time lost 10 pounds in weight. When seen only able to swallow soft food. Strongly built, but slightly emaciated. *Roentgen examination* of the esophagus showed a filling defect beginning about 8 cm. below the jugulum. The stenosis was about 6 cm. long, with a very irregular lumen only 5 mm. wide at the narrowest point. Above the stenosis, the esophagus was dilated to a width of about 4 cm. Esophagoscopy encountered, 29 cm. from the dental margin, an obstructing circular tumor, projecting especially on the posterior side, where it was distinctly papillomatous. *Rotatory irradiation treatment* (ambulant) was given from Aug. 27th to Sept. 19th: filter, 2 mm. Al.; total dose (entrance dose at 40 cm. distance), 30,500 r in the course of 19 (24) days; tumor dose, 4,300 r; daily dose, $2 \times 1{,}000$ r, except during the last week, when only $1 \times 1{,}000$ r was given daily. Strong erythema, later moderate, dry epidermitis on anterior and posterior surfaces of the thorax; hardly visible cutaneous reaction in the axillae. In the first two weeks after the treatment slight regurgitations and secretion of mucus, resulting in loss of 4 pounds in weight. No fall in blood pressure.

At the end of the treatment the deglutition was quite unimpeded. Four months later a roentgen examination showed perfectly normal passage in the esophagus, at screening the mucosa was seen to be yielding during the swallowing, the roentgenographs showed the contours smooth and sharp and the mucosal folds normal. The patient has since been entirely well, he attends to his business, eats all kinds of food and has gained 19 pounds in weight. Last seen Feb. 23rd, 1944, two and a half years after his first visit to the Radium Center. The skin on the thorax is almost natural, there is only a hardly noticeable, narrow line of pigmentation on the anterior and posterior surfaces.

Epicrisis. — Stenosing tumor, verified by roentgen examination and esophagoscopy, in the middle part of the esophagus of a man 63 years old. After rotatory irradiation treatment complete regression, normal deglutition, full working capacity, considerable increase in weight. The patient has now been symptom-free for over 2 years.

Though the tumors in the different parts of the esophagus are all accessible to rotatory in radiation, the results are not equally good in all sites. They are poorest with carcinomas in the cardia, which often prove to be adenocarcinomas arisen in the fundus of the stomach and involving a greater or smaller part of the latter. It is thus not only a question of more radioresistant growths, but also the treatment is more difficult, because the axial field must be broader, which means that the degree of effect is less and the volume dose must be increased. Nevertheless, an improvement of the deglutition can often be obtained, though in most cases only for a short time; and as a rule cachexia also sets in sooner than in the cases of true esophageal tumors. Of 36 cases in which the cardia was involved, only 5 are at present alive after more than 1 year, and none survived for over 2 years.

Of cases in which the tumor was confined to the stomach alone, we have hitherto treated only a few, because we have found it reasonable for the present to concentrate on tumors of the types and in the sites which could be expected to offer possibilities for advances in the therapy. Carcinomas of the stomach are, as a rule, larger in circumference than carcinomas of the esophagus, and are not so markedly longish in shape; their area of lymphatic metastasising is larger, they sooner involve adjoining organs, especially the liver, their location in the body is more eccentric, and on account of their histologic structure as adenocarcinomas they are more radioresistant. All these factors tend to reduce the chances of a satisfactory result of rotatory irradiation, and there can hardly be any doubt that one must be very sceptical with regard to the present possibilities of their radiologic treatment.

As regards esophageal carcinomas in other parts of the thorax, we have not found any difference either in their reaction to the rotatory irradiation, or to any marked extent, in the technical difficulty of applying the latter. Only when the tumor is situated at the level of the superior aperture of the thorax, or involves this borderline area between the cervical and the intrathoracic parts, are the anatomic conditions

more difficult for the employment of the therapy. It is true that the esophagus there lies nearer the surface, but it also lies more eccentrically and, besides, the shoulders interfere with the irradiation from the sides, during the rotation. As already said in the section dealing with the practical conduct of the treatment, the rotatory treatment can, however, with certain modifications, be used also in these cases. Eight cases, in all, in which the area at the level of the jugulum was involved, were treated in this manner; in 7 of them primary freedom from symptoms was obtained, and 3 have remained symptom-free for over 1 year.

Rotatory treatment of tumors in the cervical portion of the esophagus is no doubt technically possible, and should, on account of the considerably smaller dimensions of the neck, give a particularly good distribution of the dose if the axial field is not made too broad. But in nearly all cases there will be uni- or bilateral metastases in cervical lymph nodes, which will require that the whole of the neck is trans-irradiated homogeneously. With suitable choice of ray quality and other factors it is not difficult to ensure such homogeneity; but it is doubtful if anything is gained by it. Hitherto we have therefore in these high tumors continued to use crossfire irradiation to two or more fields, by which method we have formerly in a number of histologically verified cases obtained freedom from symptoms for several years (in 1 case for over 10 years, in 3 for over 5 years); while in one patient, who died, symptom-free, from an intercurrent disease after 4 years, neither gross nor microscopic signs of recurrence were found at the necropsy, — see later.

Discussion

Especially in these last years, in which the interest in surgical treatment of carcinomas of the esophagus has again been increasing at the same rate as advances are being made in modern thoracic surgery, we often hear from surgical quarters that radiation has no possibility whatever of acting curatively in these cases, because the carcinomas nearly always will have invaded the whole of the esophagus wall, more or less destroying the tunica muscularis; and that the result of a radiation treatment sufficiently intense to destroy all the neoplastic tissue would be weakening and perforation of the wall, and the death of the patient.

We have studied the conditions with regard to infiltration and destruction of the wall of the esophagus by the tumor microscopically in 4 very advanced cases which came to necropsy without having been irradiated. In them all, rather large portions of the tunica muscularis were not only more or less massively invaded by tumor cells, but either totally destroyed or to a various, not inconsiderable extent defective. That it nevertheless in practice, despite these conditions so unfavorable

for irradiation, has been possible to obtain complete regression of the tumor without perforation is probably not only because some of the carcinomas of the esophagus *in vivo* come to treatment earlier, and their growth is less infiltrating and destructive, than would appear to be the case from the necropsy material, which, of course, consists chiefly of highly progredient tumors; but quite as much owing to the successive selective regression of the tumor, with preservation of its bed and progressive fibroplastic regeneration and reparation from the latter, which is the characteristic and advantage of the protracted irradiation treatment and can never be forgotten by anyone who only once has seen this curious biologic process, but which is too often disregarded in surgical argumentation. Only in 3 cases of our material did necropsy disclose a perforation at the site of the tumor, where there neither by macroscopic nor microscopic examination was found tumor tissue in the margin or surroundings of the opening. As already said, it is not our impression that perforations or hemorrhages have become more frequent after we have given up crossfire irradiation in favor of rotation therapy.

In 5 cases, in which the patients died from distant metastases, no remnant of the original tumor could be demonstrated, either macroscopically or microscopically, at the necropsy. The lumen of the esophagus at its former site was in all the cases of normal width, and on close inspection there could in a small portion of the wall just barely be seen a trace of cicatricial change, and on microscopic examination the tunica muscularis was found to have to a greater or lesser extent been replaced by fibrous tissue.

Our results with the rotatory treatment must probably for the present be characterised as chiefly palliative and temporary, but all our observations hitherto indicate that it will be possible by means of this therapy to a certain, no doubt modest, yet greater extent than before to secure for the patient a longer period of freedom from symptoms and perhaps a lasting cure of this serious affection, which in spite of so many therapeutic efforts has hitherto been practically intractable. But also considered from the more modest, but at the same time more comprehensive viewpoint of its palliative effect, the rotatory method is undoubtedly a therapeutic advance. Though it certainly is an operation of some magnitude, it does not make as great demands on the patient's strength as the crossfire method, and can in most cases be carried through with less discomfort to him and with greater prospect of effect in the way of restoring normal deglutition. By the enfeebled and dejected patients, the better ability to swallow is considered as a blessing. That this improvement in many cases persists until the end contributes to alter the picture of the terminal stage of carcinoma of the esophagus, at the

same time as an indubitable lengthening of the average time of survival is obtained.

About the proportion of cases in which lasting results may be expected, nothing can be said with certainty until further experience shall have been gained; but owing to the late stage at which the tumor is recognized, and the tendency to early metastasising, the percentage will no doubt be small; for the whole group of cancers of the esophagus experience so far does not seem to give hope of 5 years' freedom from symptoms in more than a few per cent, perhaps 5. Since the present proportion of lasting therapeutic results is undoubtedly less than 1 per cent even so modest an advance will, however, be of considerable relative value, and will stimulate to further therapeutic experiments.

To judge from the newest literature on surgical treatment of cancer of the esophagus, especially the communications from the U. S. A., there seems to be a tendency to deny that radiation treatment has any curative, or even essentially palliative effect in that disease. According to our experience this does not accord with actual facts. To us, there is no doubt that the difficult task of trying to treat esophagus cancer both radically and symptomatologically will to a very great extent continue to be the domain of radiotherapy. All imaginable advances of thoracic surgery notwithstanding, only a small percentage of carcinomas in the esophagus will be amenable to surgical treatment, and the number of these in which a complete cure will be obtained will be smaller, still. It must be remembered that until a few years ago TOREK's case of extirpation of an intrathoracic esophageal cancer was unique as far as long-lasting freedom from symptoms is concerned. On the other hand, the literature contains not a few records of long-lasting cures by radiologic treatment. It would carry us too far to review these cases here; but there may in this connexion be occasion to call for the publication of all radiation-treated cases of carcinoma of the esophagus which have remained symptom-free for any considerable length of time, particularly such of which the diagnosis has been verified histologically. To the documentation of the efficacy of the radiologic treatment we can ourselves contribute with the following 5 cases, all in the cervical part of the esophagus, which were cured by fractioned crossfire irradiation with roentgen.

Case 1. — Woman, 48 years old, referred to the Radium Center Nov. 2nd, 1932. For 4 months she had had pains in the throat; later, the deglutition had become increasingly difficult. Roentgen examination of the hypopharynx and esophagus showed displacement, forwards, of the larynx and trachea, by a large prevertebral soft tissue shadow, which could be followed right down in the jugulum. After ingestion of contrast fluid, a filling defect, about 5 cm. long, was seen, beginning a little below the mouth of the esophagus. Esophagoscopy showed in the upper end of the organ a papillomatous,

ulcerated tumor tissue, closing the lumen; which by biopsy was found to be a squamocellular carcinoma of the mucosal type. No palpable lymph nodes in the neck. *Protracted fractioned roentgen treatment* was given: half layer value, 1.5 mm. Cu.; distance, 50 cm.; 5 r/min.; 2 fields, from right and left; size of fields, 8×10 cm.; total dose, 5.150 r, in 40 irradiations distributed over 19 (22) days. Slight exudative epidermitis on the fields on the neck; rather strong epithelitis in the hypopharynx. The tumor regressed completely, the deglutition became entirely normal. The patient felt quite well and was symptom-free for $11^1/_2$ years. Some years after the irradiation, a slight myxemeda developed (basal metabolism, 84 per cent), against which thyroidin in small doses was given with good effect. In September, 1943, nearly 11 years after the treatment, an operable cancer, the size of a green walnut, was demonstrated in the left breast. Trephine biopsy showed it to be a »gelatinous adenocarcinoma». Preoperative roentgen irradiation was given, and 6 weeks later radical operation was performed. The patient is now, 6 months after this operation, without any symptoms of the mammary cancer.

Case II. — Woman, 69 years old, referred to the Radium Center Sept. 29th, 1935. For 2 years past, she had had a feeling as of a lump in her throat, and deglutition had been difficult. Roentgen examination showed a filling defect in the upper part of the esophagus, from a little below the mouth of the latter and about 3 cm. downwards. Esophagoscopy revealed a projecting, ulcerated tumor in the posterior wall, about 5 cm. below the cricoid cartilage. Biopsy showed it to be a squamocellular carcinoma with parakeratosic onion formations. There were no palpable lymph nodes in the neck. *Protracted fractioned roentgen treatment* was given: half layer value, 1.5 mm. Cu.; distance, 70 cm.; 2.5 r/min.; 5 fields, sizes 50 to 125 cm².; total dose, 12,450 r in 85 irradiations distributed over 56 (65) days. Dry epidermitis, slight epithelitis. At the end of the treatment, the patient could eat all kinds of food without difficulty, and roentgen examination showed normal passage. Four years afterwards she died from coronary thrombosis. At necropsy, the mucous lining of the esophagus was found smooth and natural-looking, without signs of recurrence. There were no infiltrations anywhere; and none, either, in the tissue about the esophagus.

Case III. — Man, 70 years old, referred to the Radium Center April 25th, 1930, with a large, flat, ulcerated cancer of the uvula and soft palate, which on examination proved to be a solid, cornescent carcinoma. No lymph nodes in the neck. Became symptom-free after roentgen treatment and electrocoagulation. Three years later, in April, 1933, ulcerated cancer in the left arytenoid region, extending out into the piriform sinus. Microscopy showed squamocellular carcinoma of the mucosal type. Metastasis to lymph nodes in the right side of the neck. Symptom-free after protracted fractioned roentgen treatment. Two and a half years later, deglutition became difficult. Roentgen examination of the esophagus in January, 1936, showed an irregular stenosis, caused by a tumor, at the level of the jugulum. At esophagoscopy, a large tumor with unevenly ulcerated surface was encountered, which biopsy showed to be a solid carcinoma. No palpable lymph nodes in the neck. *Protracted fractioned roentgen treatment* was given: half layer value, 1.5 mm. Cu.: distance, 70 cm.; 2.5 r/min.; 3 fields, size about 80 cm².; total dose, 7,900 r in 35 (42) days. Dry epidermitis. The difficulty of swallowing ceased. The patient remained free from symptoms from any of the three carcinomas in the upper alimentary tract until his death, from pneumonia, at the age of 81 years, Oct. 25th, 1941, five and a half years after the roentgen treatment of the tumor in the esophagus. At the necropsy, no signs of recurrences were found either in the latter or in the hypopharynx or the oral cavity. The mucosa of the esophagus, at the site of the former tumor, was smooth and to all appearances normal.

Case IV. — Woman, 31 years old, referred to the Radium Center Nov. 12th, 1936. Her deglutition had been difficult for ten years, and she had at different periods suffered from anemia. There was marked Plummer-Vinson syndrome, with some atrophy of the lingual papillae, rhagades at the commissures of the lips and anemia. Roentgen-examination of the esophagus showed a stenosing filling defect, 5 cm. long, extending from a few centimeters below the mouth of the esophagus down to the level of the jugulum. Esophagoscopy encountered about 20 cm. from the dental margin a circular, vallate, ulcerated stenosis. Biopsy showed spinocellular carcinoma. In the left supraclavicular region there were 2 firm lymph nodes, the size of large peas. *Protracted fractioned roentgen treatment* was given: half layer value, 1.5 mm. Cu.; distance, 65 cm.; 2.5 r/min,; 2 fields, from right and left; size of fields about 80 cm.^{2}; total dose, 6,260 r in 29 (37) days. Slightly exudative epidermitis. The patient has since been without signs of recurrence for 7 $^1/_2$ years, but can only swallow soft and liquid food, because a cicatricial stenosis has developed, which it has been impossible to dilate by bougie treatment. (A plastic operation is at present being contemplated.)

Case V. — Woman 61 years old, referred to the Radium Center Feb. 4th, 1939, For 3—4 months she had had a feeling as if there were a foreign body in her throat, and had had difficulty in swallowing. Roentgen examination showed a prevertebral thickening of the soft tissue at the level of the upper part of the cervical portion of the esophagus. At esophagoscopy, an ulcerated neoplastic tissue was seen in the posterior wall, corresponding to the mouth of the esophagus. Biopsy showed squamocellular carcinoma of the mucosal type. In the left side of the neck there was a hazelnut-sized lymph node metastasis. *Protracted fractioned roentgen treatment* was given: half layer value, 1.5 cm. Cu.; distance, 72 cm.; 2.5 r/min.; 2 fields, from right and left; size of fields in the beginning about 80 cm.^{2}, later about 50 cm.^{2}; total dose, 7,050 r in 42 (48) days. Dry epidermitis and strong epithelitis in the hypopharynx. The patient has since been symptom-free for 5$^1/_2$ years, and the deglutition is entirely normal.

To the credit side of radiologic therapy can now be further added the rotatory treatment, and it is our belief that the results of the latter will henceforth contribute to improve the standing of radiotherapy so far as the treatment of carcinoma of the esophagus is concerned; because the rotation therapy better than any of the radiologic methods hitherto employed is able to overcome the almost insurmountable anatomic and physical difficulties which radiotherapy formerly encountered in dealing with intrathoracic carcinomas of the esophagus. The method hitherto, and probably still, most frequently employed in these cases is no doubt crossfire irradiation with fractioned doses. The shortcomings of this method, to which I have already referred several times, may briefly be summarized as uncertainty of the technique of adjustment, larger fields, — resulting in larger volume doses and stronger general reactions, — and inhomogeneous dosage, with crossing of rays both in the periphery and in the field of concentration.

Treatment with radium bomb has only been used a few times. The deep dose must be considered as inadequate for carcinoma of the esophagus.

Intra-esophageal brachyradium treatment in the form of insertion of radium tubes into the carcinomatous strictures, or radium puncture through esophagoscope, with emanation tubes, chiefly gold seeds, which can be left *à demeure*, has been used and is recommended by several authors. The first of these methods gives, however, a very uneven distribution of the intensity, and, owing to the very short treating distance an abrupt fall in the latter away from the source of radiation; therefore curative results are seldom obtained. But it can give good palliative results; the passage through the esophagus is kept open, and at the same time the volume dose is small. On the other hand the risk of perforation restricts its serviceability and requires that circumspection be used in the selection of the cases in which it is employed. The same applies in even higher degree to radium puncture, which can only be employed within still narrower limits and involves even greater risks. For the present it must remain an open question whether there in the future will be any use for the intra-esophageal brachyradium treatment as supplement to the rotation therapy. If so, it had no doubt best be applied after the latter, when the stenosis has been overcome and the radium preparation can be introduced into the esophagus with less risk.

It will be more reasonable, though, to concentrate on improvements in the rotation therapy itself. Such improvements may be expected particularly on two points, a clinical, radiobiologic, and a technical. In the first place we may hope that as our knowledge respecting the influence of the time factor on the irradiation of the normal and neoplastic tissues increases, it will become possible to improve the dose distribution in time, in the second, the intensity distribution during the rotatory irradiation might be bettered by using a more penetrating radiation, with shorter wave lengths. This requires a considerable increase of the tension under which the rays are produced (400—1,000 kv.), and corresponding stronger filtration. Preliminary measurements, which we have made on phantoms, with irradiation with half layer values of 6—8 mm. Cu. (850 kv. max; 0.5—1 mm. Pb.) show a noticeable improvement of the distribution of the intensity (the degree of effect); which is probably due partly to the better depth dose, partly to better limitation of the beam in the irradiated object, because the secondary radiation with increasing kilovoltage becomes directed more and more forwards in the same direction as the entering primary. We hope to be able in a near future to present a separate report of the results of our studies of this subject.

In conclusion, I may sum up the whole foregoing discussion by saying that our clinical experience, so far, with rotation therapy in cancer of the esophagus, especially of the intrathoracic portion of that organ, seems to show that by this form of radiation treatment it may become possible to obtain better results than hitherto in dealing with these tu-

mors, which, owing to their deep location are so difficult to treat; so that not only a larger proportion than before may be given palliative treatment, but also cures, which have hitherto been so rare, may somewhat oftener be obtained. Besides, there is prospect that the rotation therapy may be further developed, technically, by the use of very hard rays (millionvolt roentgen rays).

SUMMARY

The author presents his observations and experiences with rotation therapy in cancer of the esophagus on the basis of a material of 174 cases treated at the Radium Center in Copenhagen. He maintains that the highest degree of effect is obtained when the focus-axis distance and the half layer value are as great as possible, the size of the field and the object, and the density of the latter, as small as possible; and he points out that the shape of the object plays a rôle as regards the distribution of the intensity. He describes the dispositions for the irradiation and the practical conduct of the treatment, and stresses the importance of working with the smallest possible axial field, and of the constant screening control.

Of the 174 cancers of the esophagus treated by this method at the Radium Center in Copenhagen during the years 1941, 1942 and 1943, 8 were situated in and about the portion at the height of the jugulum, 166 entirely within the thorax. 118 cases were treated with a radiation with half layer value of 0.3 mm. Cu., 56 with a radiation with half layer value of 0.9 mm. Cu.

The curative tumor dose was about 5,000 r in the course of 5—6 (7—8)weeks. The cutaneous reaction is, at most, a moderate, dry epidermitis, most strongly pronounced on the anterior and posterior surfaces of the thorax. The general reactions were markedly slight. Fall in blood pressure was often observed, but was, as a rule, not of a nature to cause noticeable trouble or discomfort to the patient. Cicatricial stenoses following the treatment could be blocked out.

As primary results, freedom from symptoms or marked improvement was obtained in 117 cases (= four-fifths of the fully treated cases, or two-thirds of the total number). Twenty-five per cent of the patients are alive after 1 year, 15 per cent after 2 years. Some characteristic case histories are related. Cancers in the cardia responded least well to the treatment.

An evaluation is made of the rotation therapy, the surgical treatment, and the forms of radiologic treatment hitherto used, in dealing with cancer of the esophagus. All cases cured by radiotherapy should be published. In the author's opinion the treatment of cancer of the esophagus also in the future will be chiefly the domain of radiotherapy. Observations so far seem to show that the preferable treatment will be by rotatory irradiation, which may be still further improved by the use of yet more penetrating radiation (millionvolt roentgen rays).

ZUSAMMENFASSUNG

Verf. legt seine Beobachtungen und Erfahrungen mit der Rotationstherapie bei Speiseröhrenkrebs an Hand eines Materials von 174 in der Radiumzentrale in Kopenhagen behandelten Fällen vor. Er betont, dass die stärkste Wirkung erzielt wird, wenn der Fokus-Achsen-Abstand und die Halbwertschichtdicke so gross wie möglich, der Umfang des Feldes und des Objekts sowie die Dichtigkeit des letzteren hingegen mög-

lichst klein sind, und macht darauf aufmerksam, dass die Form des Objekts für die Verteilung der Intensität eine Rolle spielt. Er beschreibt die Anordnung der Bestrahlung und die praktische Führung der Behandlung und betont die Wichtigkeit des Arbeitens mit möglichst kleinem Axialfeld und der konstanten Kontrolle mittels Durchleuchtung.

Von den 174 in den Jahren 1941, 1942 und 1943 in der Radiumzentrale in Kopenhagen mit dieser Methode behandelten Fällen von Ösofaguskrebs sassen 8 auf der Höhe des Jugulum oder in dessen Nähe, 155 ganz und gar innerhalb des Brustkorbes. 118 Fälle wurden mittels Bestrahlung mit einer Halbwertschichtdicke von 0.3 mm Cu behandelt, 56 mit einer HWS von 0.9 mm Cu.

Die kurative Tumordosis betrug etwa 5,000 r in Laufe von 5—6 (7—8) Wochen. Die Hautreaktion besteht höchstens in einer mässigen, trockenen Epidermitis, die an der Vorder- und Hinterfläche des Brustkorbes am stärksten ausgesprochen ist. Die Allgemeinreaktionen waren auffallend gering. Sinken des Blutdruckes wurde oft beobachtet, war aber in der Regel nicht der Art, dass es dem Kranken merkbare Schwierigkeiten oder Unannehmlichkeiten bereitet hätte. Auf die Behandlung folgende Narbenstenosen konnten dilatiert werden.

Als Früherergebnisse wurden Symptomfreiheit und ausgesprochene Besserung in 117 Fällen erzielt (d. h. in 4/5 der voll behandelten Fälle oder 2/3 der Gesamtzahl). 25 % der Kranken leben nach 1 Jahre, 15 % nach 2 Jahren. Es werden einige charakteristische Krankengeschichten wiedergegeben. Krebs der Kardia spricht am schlechtesten auf die Behandlung an.

Der Wert der Rotationstherapie, der chirurgischen Behandlung und der bisher bei Ösofaguskrebs verwendeten Formen von radiologischer Behandlung wird besprochen. Alle mit Radiotherapie geheilten Fälle sollten veröffenlicht werden. Nach Ansicht des Verf.s wird die Behandlung des Ösofaguskrebses auch in Zukunft hauptsächlich ein Gebiet für Radiotherapie darstellen. Die Beobachtungen scheinen bisher zu zeigen, dass die Rotationsbestrahlung die Methode der Wahl sein wird, die durch Verwendung von noch stärker durchdringender Bestrahlung (Millionvolt-Röntgenstrahlen) noch weiter verbessert werden kann.

RÉSUMÉ

Se fondant sur un matériel de 174 cas traités au Centre du Radium à Copenhague, l'auteur rend compte de ses observations et de ses expériences dans le domaine de la thérapeutique rotatoire du cancer de l'œsophage. Il affirme que pour obtenir les meilleurs résultats il faut utiliser une distance foco-axiale et une couche de demi-absorption maxima tandis que les dimensions du champ et de la tumeur ainsi que la densité de cette dernière doivent être aussi réduites que possible; il souligne le fait que la forme de la tumeur joue un rôle dans la distribution de l'intensité. Il décrit la technique de l'irradiation, la conduite pratique du traitement en soulignant l'importance de l'irradiation d'un champ axial minimum et du contrôle radioscopique permanent.

Des 174 cas traités par sa méthode au Centre du Radium à Copenhague durant les années 1941, 1942 et 1943, 8 étaient situés au niveau de la clavicule ou dans son voisinage, 166 dans la portion thoracique. 118 cas furent irradiés sous couche de demi-absorption de 0.9 mm. Cu.

La dose curative pour tumeurs atteignit 5,000 r environ au cours de 5—6 (7—8) semaines. La réaction cutanée est, au pis, une épidermite sèche modérée, marquée surtout aux faces antérieure et postérieure du thorax. Les réactions générales furent très légères. La chute de la pression sanguine, symptôme fréquemment observé, ne fut généralement pas de nature à causer des troubles ou des désagréments notables au malade. Il fut possible de dilater les sténoses cicatricielles consécutives au traitement.

Comme résultats primaires, l'auteur obtint dans 117 cas (c'est-à-dire dans les $^4/_5$ des cas traités à fond et les $^2/_3$ du nombre total) la disparition des symptômes. 25 % des malades ont survécu un an, 15 % deux ans à la suite du traitement. L'auteur relate quelques anamnèses typiques. Ce furent les cancers du cardia qui résistèrent le plus à l'amélioration.

L'auteur compare la thérapeutique rotatoire, le traitement chirurgical et les formes de traitement radiologique utilisées jusqu'ici dans le cancer de l'œsophage. Tous les cas guéris par radiothérapie devraient être publiés. Dans l'opinion de l'auteur, la radiothérapie sera à l'avenir le traitement de choix du cancer de l'œsophage. Les observations réunies jusqu'ici semblent démontrer que le traitement auquel on devra donner la préférence sera la radiothérapie rotatoire sans cesse perfectionnée par l'usage de rayons de plus en plus pénétrants (rayons de roentgen de millions de volts).

FROM THE ROENTGEN DEPARTMENT OF CARLANDERSKA SJUKHEMMET, GOTHENBURG
(CHIEF PHYSICIAN: DR. H. ODQVIST)

A ROENTGEN CINEMATOGRAPHIC STUDY OF THE MOVEMENTS OF THE MITRAL RING DURING HEART ACTION[1]

by

Henning Odqvist

In an appendix to an article entitled »Studien über den Röntgenbefund bei intrakardialen, speciell perimitralen Verkalkungen», Acta Radiol. Vol. XXV, 1944, I have mentioned in a preliminary statement a roentgen cinematographic registration of the movements displayed by a calcareous deposit in the mitral fibrous ring during heart action.

Having on repeated and careful examinations of the cinematographic film found some additional details in the movement-curve I want to give an account of these later observations and at the same time to describe the technique employed in making such a film.

For several reasons screen examination has certain limitations when studying the movements of the mitral ring. For one thing the time of exposure must be very brief and the radiation intensity has to be relatively low in order to avoid injuries. Owing to the insufficient power of perception of the eye subtile details of the movement cannot be discerned at all by this method. As LAURELL puts it: »The eye is too coarse an organ for the detailed observation of heart pulsations.» This applies, in a still higher degree, to the movements of small calcareous cardial deposits. Two roentgenographic methods, i. e. *Cymography* and *Cinematography* may be of help in such a case. I have employed the last mentioned method when studying more closely the movements of the mitral ring. In the first place I want to submit a few data from the record of the examined case.

The patient, a woman aged 76, who was extremely lean, had during some years shown signs of cardial sclerosis. She had never suffered from articular rheumatism. Auscultation revealed a rough systolic murmur, most pronounced over the apex. P^{II} was slightly accentuated. *Blood pressure:* 210 mm. Hg. *Ecg.* Sinusarythmia and coronary disturbances.

[1] Submitted for publication, Febr. 9, 1945.

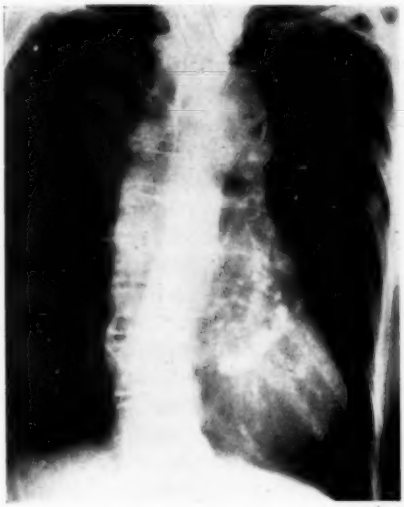


Fig. 1. Horseshoe shaped calcification in the mitral fibrous anulus.

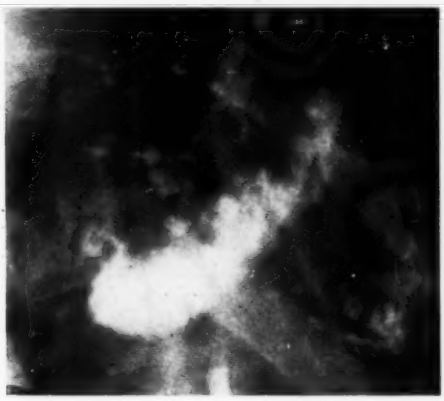


Fig. 2. Close-up picture of the calcareous deposit.

By fluoroscopy of the heart a horse-shoe shaped calcareous deposit, the size of a little finger, was found in the mitral fibrous ring. The incrustation, being thickest at the back, corresponding to the insertion of the posterior lateral valve narrowed in the anterior direction. During ventricular systole the deposit was displaced well over one centimeter towards the apex. The pulsations of the left ventricle were remarkably small. During the systolic phase the apex of the heart only moved a few millimeters upwards. The aortic arc was the site of distinct calcareous deposits. The heart did not show any pronounced vitium configuration.

The patient being very lean and the mitral deposits being comparatively pronounced the case appeared to me to be suitable for an attempt at closer cinematographic study.

The technique of the roentgen cinematography

The technique employed was the *indirect* method by which the screen picture of the heart is cinematographed.

After roentgenoscopy and focussing of the heart a powerful exposure was made during 3 seconds at a tension of 100 kilovolts and an intensity of 100 milliampères using a specially constructed fluorescent screen (Superastral) of high luminosity. The roentgen tube will not stand the

strain of such charging more than three seconds during which the cinematography has to take place.

Later, when the tube had cooled off, renewed exposures were made in different projections. The different exposures were subsequently repeatedly recopied and joined together into a film. The Bell & Howell 16 millimeter cinecamera used was fitted with a very powerful objective (Zeiss' optik, Röntgenbiotar, f: 0.85), sixteen as well as thirtytwo pictures per second being taken on cine codak film xx.

The photographic apparatus fully equipped was placed at my disposal through the kindness of professor ÅKE ÅKERLUND to whom I take the opportunity of expressing my sincere gratitude. 'Hasseblads fotografiska', Stockholm, rendered the necessary photographic service.

To make a roentgen cinematographic film registering only the changes in heart configuration due to superficial pulsations does not nowadays present great difficulties, *but to register intracardial calcifications and the course of movement described by them is quite a different matter and approaches, in fact, the border line of present day technical achievement. Only where the patient is very lean and the calcareous deposits considerable can success be expected.* As previously stated, both conditions were fulfilled in this case.

As roentgen light, like ordinary light, decreases in a ratio corresponding to the squared distance, it is of the greatest importance that the distance between the roentgen tube and the fluorescent screen should be as short as possible. In addition the cinematographic film used not only has to be particularly sensitive to light, but must also be specially sensitized to the yellow-green light emitted by the fluorescent screen (supersensitive xx).

The developing of the film which requires a special technique, results in a positive film. When subsequently copied a negative is obtained which is used at the projection. The contrast is increased by this procedure.

The result of the cinematography. The movement curve of the mitral ring

On projecting the reel the movements of the calcified mitral ring during heart action are demonstrated as plainly as anyone could wish. When carrying out an ordinary screen examination the impression is conveyed that the mitral ring is moving in a *linear course* pointing towards the apex of the heart during ventricular systole while this latter is simultaneously displaced in cephal direction. On closer scrutiny of the cinematographic representation, however, *it becomes apparent that the course is really a triangular one.* Thus the mitral ring in the first place moves vertically downwards in the direction of the diaphragmatic cupole during ventricular

systole. *Directly before reaching its lowest position it moves with a jerk in the direction of the apex of the heart.* Diastole produces a cephal movement along the hypotenuse of this triangle. At the upper part of the returning diastolic course a brief pause arises, during which the deposit stops while appearing to vibrate, followed by *a quick return to its top position. This latter movement, being executed at a considerably greater speed than the others, gives the impression of being caused by a muscular contraction. Presumably the phenomenon is produced by a contraction of the left auricle pulling the mitral ring above its equilibrium.* Immediately afterwards the downward movement begins.

With the greatest probability the part of the course of movement situated between the pause and the top position referred to above represents the presystolic phase.

Fig. 3. The movement curve of the mitral ring during heart action.

Cinematography as compared with roentgen screen examination yields a much more detailed picture of the trajectory described by the calcified fibrous anulus. In addition the method enables a more comprehensive conception of the extension of the deposit.

Thus small linear and granular ramifications from the calcareous ring into the left auricular as well as the left ventricular walls which were not discernible by roentgenoscopy or roentgenography appeared distinctly on cinematographic projection on account of their movements.

Another advantage of such a film is that it can be run *repeatedly and at different speeds* thus providing opportunities of analyzing the movements in detail at leisure away from the patient and the roentgen tube and without time-wasting adaptation as contrasted with the hurried efforts at forming an opinion during the few minutes available in screen examination.

I am not aware whether any roentgen cinematographic film registering the movements of the mitral ring has been previously produced. Accordingly it is difficult to decide whether the triangular course of movement described in this paper is a *physiological phenomenon* or should be considered as a *sign of incoordinated contractions of the heart muscle* presumably caused either by the ramifications from the perimitral calcification into the surrounding myocardium or by the coinciding coronary disturbances, which were both, as stated before, present in this case. Only subsequent cinematographic studies will decide on this question. It would

evidently have been of great interest in this case, if it had been possible to arrange for an electrocardiogram to be made at the same time, but the technical resources were not available, and the elderly patients' poor condition made it imperative to carry out the examination in the shortest possible time.

Undoubtedly the roentgen cinematographic method will in the future play an important rôle, and there is reason to hope that further technical progress will improve and cheapen the method to such an extent as to make it available in every roentgen department.

SUMMARY

The author describes a cinematographic registration of the mitral ring during heart action in a case suffering from calcified mitral fibrous anulus. The course of the movement was shown to be *triangular. The presystolic phase was marked by a quick pull upwards of the ring above its equilibrium, presumably due to contraction of the left auricle.*

ZUSAMMENFASSUNG

Verf. berichtet über eine kinematographische Aufnahme der Bewegungen des Mitralisringes bei der Herzarbeit bei einem Falle von Verkalkung des Annulus fibrosus. Hierbei wird darauf aufmerksam gemacht, dass die Bahn der Bewegung *dreieckig* ist. Die *Präsystole* zeichnet sich durch eine *rasche* Hochziehung des Ringes über seine Gleichgewichtslage aus, wahrscheinlich veranlasst durch eine *Kontraktion des linken Vorhofs.*

RÉSUMÉ

L'auteur rend compte de la prise d'images cinématographiques des mouvements de l'anneau mitral pendant l'activité cardiaque dans un cas de dépôts calcifiés dans l'anneau fibreux. Il rend attentif au fait que le diagramme du mouvement est triangulaire. La présystole est marquée par une élévation *soudaine* de l'anneau au-dessus de sa position d'équilibre, causée vraisemblablement par la contraction de l'oreillette gauche.

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FROM THE NORWEGIAN RADIUM HOSPITAL (CHIEF: ROLF BULL ENGELSTAD, M. D.)

ON KELOIDS AND THEIR TREATMENT[1]

by

Sverre Strand.

The keloid is a cutaneous proliferation of connective tissue that by some is included under benign tumors, but whose tumorous nature is being disputed by others. HINTZE calls the keloid the special tumor of the cicatricial tissue. In dermatological text-books it is stated that the keloid has been mentioned for the first time by RETZ (1790); it has been described more closely by ALIBERT (1810). It is a new-formation in the skin of a solid, elastic consistency, the shape and appearance of which may vary greatly. It forms node-like prominent thickenings in the skin, supplied with string-like often radially arranged processes. In extent it may be from small grain-sized nodes to the size of the palm of a hand and larger. It may protrude slightly above the surrounding skin, but the prominence may also be considerable, 10—15 mm. The colour may be from bluish-red and pink, to pale. The surface is smooth. Its name, keloid, means claw of a crawfish.

Usually it commences as a small, pale pink, grain-sized node in the skin, and then as a rule in a fresh cicatrix after an injury or ulceration; however, it may also appear in apparently normal skin. The growth is slow, through months and years, ceases gradually, and also may recede somewhat. The pink colour pales as the keloid grows older. The surface is smooth, scar-like, without hair, sweat-nor sebaceous glands.

The actual cause for the growth of keloid in the skin is unknown. However, it denotes a predisposition to react to changes in the outer skin with pathologic increase of connective tissue new-formation. This predisposition seems to be partly locally, partly generally developed, partly also limited in time. Further it is individual, as certain people react very readily to traumas with development of keloid, whereas by far the majority never show such predisposition. Finally, it may apparently be a family predisposition. It is specially pronounced in certain races; thus some coloured tribes make use of it for adorning

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themselves with some kind of tattooing with secondary keloid development.

Keloid-growth thus appears in predisposed individuals with changes in the outer skin. These changes are mostly traumatic injury of the skin, lesions, burns, injuries by caustic agents, and as it seems, specially when there has been suppuration in the wound. Besides from traumatic lesions keloid may develop from an inflammation in the skin, after acne, herpes, zoster, leprous, luetic and tubercular sufferings. Some locations are remarkably frequent, e. g. keloids in the skin over the sternum. The reason for this location is given partly to be due to scratching the skin, produced by the here so frequently located simple pityriasis.

For the rest the location may be anywhere, entirely dependant on the location of the releasing trauma. Usually there is only a single keloid, however, they may also occur multiply, they are observed in hundreds, scattered all over the body.

In the reticular layer of the skin histologically it is found a monstrous growth of connective tissue, covered by a thin, non-papillous, slightly or not cornified skin. In the keloid the elastic fibres have been displaced. In a young, growing keloid it is found rich infiltration of round cells, that vanish in the later stages. The same holds for the vascularity, that in early stages is rich and gives to the keloid its red colour. The number of vessels is gradually reduced, and in old keloids one finds solid masses of connective tissue that is poor in vessels. The affection preferably develops longside the blood-vessels, which it follows in its further growth. This will explain its branched spreading. It has been sharply differentiated between true or spontaneous keloids, and false or cicatricial keloids, and also hypertrophic cicatrices. This division of keloids into several groups today is more disputed, as it is believed that the so-called true or spontaneous have developed in overlooked or forgotten small injuries in the skin, such as wounds caused by scratching or in the site of an old acne-pustule, or merely after a blunt trauma that has caused a bursting of the skin underneath the epidermis (A. Simons, W. Baensch). Neither is there any essential difference nor definite borderline between hypertrophic cicatrices and what is termed keloids.

Common to all keloid growths is that they show no tendency to malignant development, but must be regarded as an entirely benign condition.

In old scars with keloid nodes it has been observed the development of cancer in epidermis without any causal connection between the keloid and the cancer.

The further development of the keloid usually is such that after some time the growth ceases, it pales and gradually the consistency becomes solid. As a rule it then remains for life as a pale, solid tumor

in the skin. A few keloids, however very few, are capable of showing spontaneous regression.

In most cases the keloid gives subjective symptoms, as it is accompanied by pain in form of itching, stinging and burning sensations, and it may be very sensitive to touch and pressure. This pain may be very pronounced, however, it may also be entirely lacking. The pain usually grows somewhat easier with the years, but sometimes it is permanent.

A protruding keloid tumor with radial, claw-like processes is cosmetically disfiguring, and the patient is as a rule very sensitive just on this point, and this is one of the main reasons why he seeks treatment.

Diagnosis of the keloid is usually very simple. The multiple keloids sometimes recall multiple sarcomas, but the appearance of the keloid, with its smooth, atrophic skin and characteristic branched spreading renders the diagnosis an easy matter. Also the histological picture is characteristic, but biopsy and histological examination are as a rule unnecessary.

When considering the question of treatment of the keloid, first the cause of the development of keloid growth is unknown, and therefore causal treatment cannot be given, nor any preventive treatment. However the suffering is cosmetically disfiguring, it is often painful and may cause functional disturbances, and therefore it should be treated. Earlier, various treatments have been tried for keloids, with very unsatisfactory result however. If the keloid is attempted surgically removed recurrence will practically always appear, and often it will be larger than the original keloid, this whether knife, thermo-cautery or electro-coagulation has been used. Of medications, iodine, salicylate acid, mercury, fibrolysin and thiosiamin have been tried, without mentionable result. Massage, baths, permanent bandage have been tried without effect. Electrolysis is supposed to have had some effect in a few cases, far from satisfactory however. Finsen's light treatment either has no effect or it aggravates the symptoms, especially the pain. The same is true for natural sun-light. The functional disturbances have also been difficult to treat, as after attempt of surgical plastic new keloid developed in the operational cicatrix. The treatment therefore for long gave small satisfaction.

In 1898 L. FREUND reported observations of flattening of hypertrophic cicatrices by roentgen treatment. In 1905 WILLIAMS published an account of favourable effect of radium treatment. Both roentgen and radium soon received recognition. It proved that by irradiation keloids might be brought to recede nicely, and after such treatment there was no recurrence. Even when the irradiation only produced partial regression of the keloid this effect was permanent.

Gradually radiumtreatment as a method has come to be preferred to roentgen, as its effect has proved more rapid and certain. Also it is capable of more accurat and more limited application, because of the more rapid fall in intensity with the distance (DEGRAIT and BELLOT).

The purpose of the radio-therapy has been to obtain a soft, pale, painless cicatrix on the skin level, and such flattening and improvement of the subjective symptoms is practically always obtainable.

Not all keloids react equally to irradiation, as various conditions in connection with the keloid have effect on the result, such as the age of the patient; children and young individuals react more readily to the treatment than do older people. Further the age of the keloid is of some importance, as young and vascular keloids react better than old ones, that have become solid and poor in vessels.

In 1909 L. FREUND proposed a combination of surgical excision of the keloid and subsequent irradiation. This combined treatment would seem serviceable, as one by excision of an old keloid that is poor in vessels and therefore only slightly radio-sensitive, gets this replaced by a vascular cicatrix, even though with an inherent tendency to keloid growth. This scar should then be more easily influenced by irradiation and the tendency to recurrence would, to be hoped for, simultaneously disappear; however, keloids are often so large that they cannot be surgically removed, or if such procedure is practicable, the cicatrix left will often be no more cosmetically satisfactory than was the original keloid. Experience further shows that one is not safe against recurrence of the keloid even after postoperative irradiation (H. FUSS), nor after preoperative irradiation, as proposed by SHERMAN. Where the keloid is localized over a joint and impedes its functions, a combined treatment will still be indicated, such that an excision of the keloid by plastic operation is followed by radio-therapy, in order to prevent recurrence, if possible.

Otherwise the combined treatment is rarely used today, not only because the result is unsatisfactory, but also because irradiation alone has given such good result.

Thus the form of irradiation that has proved most serviceable is the radium treatment, and here the most various methods have been applied. SIMONS and BAENSCH are using intubation of needles into the keloid tumor, whereas HINTZE believes that the introduction of needles means a trauma that would predispose for new keloid growth. Instead he uses radium-moulds.

BAENSCH has treated 36 cases with radium intubation and gives his result as follows: 13 gave very satisfactory cosmetic result, 11 quite good result and 6 improved, whereas 6 showed no mentionable result. Simultaneously he gave roentgen treatment in 22 cases with the following results: 8 cosmetically very satisfactory, 4 quite good, 3 somewhat im-

proved, whereas as many as 7 showed no mentionable effect. The exact dosages have not been accounted for.

At the Norwegian Radium Hospital 117 cases of keloid have been treated in course of the decennium 1933—1942. Some of these keloids have previously received surgical treatment, but recurrences have appeared. In 2 cases the patients were admitted for postoperative radiotherapy. The releasing causes of these keloids were: Combustion: 37 cases, congelation: 1, caustic injury (lye, acid): 3, vaccination for smallpox: 12, traumatic wounds, mostly with suppuration: 39, operational cicatrices 15, wounds in the baby skin received during birth: 1, no reason given, »spontaneous»: 9.

In the burns as well as in the traumatic wounds there have been considerable suppuration, which is supposed to be of importance to the growth of keloids in a wound. Also in the vaccination wounds, which makes 10 % of the total material, there is suppuration. These suppurating wounds with additional 3 cases of wounds caused by caustic agents, makes in all 78 % of the total amount of cases.

One keloid had developed in the mucous membrane on the inside of the cheek after extraction of a tooth. This happened in the case of a woman of 53 years, who after extraction of a tooth developed a typical keloid in the mucous membrane, with radiating processes, elevated above the surrounding mucous membrane. It had been attempted surgically removed a couple of times, however recurrence appeared.

In 9 cases the patient has been unable to give any cause for the keloid growth. However, as already mentioned, there might easily have been a trauma or injury of the skin that has been overlooked. Therefore the author agrees with SIMONS and BAENSCH in being doubtful towards the concept of spontaneous keloids. In the 9 cases in which the patients were unable to specify any direct cause the keloids had the following location: 1 on back of the neck, 1 on thorax, 1 on the upper arm, 1 in the face, 3 over sternum, 1 in the gluteal region and 1 in maxilla. In our entire material the keloid was localized over the sternum in 16 cases, equally distributed between men and women, 8 of each sex. The statement by BAENSCH that this location is most common in women, because of tension and stretching of the skin from mammae thus finds no support.

Of the total material 80 were women, which makes a remarkable surplus. However, even so, from these numbers it may hardly be drawn any conclusion as to a more marked tendency to keloid growth in the female. It should be remembered that the essential reason why the patients demand treatment is the fact that the keloid is cosmetically disfiguring, which may explain the great surplus of women.

18 of our patients have previously had their keloids surgically treated, however with recurrences, the new-growth often having a greater extent

than the original keloid. The surgical treatment has consisted in simple excision or electro-coagulation.

The family predisposition to keloid development on 2 occasions has been expressed in the present material. First there are 2 sisters, 19 and 4 years respectively, who have been exposed to burning at various times, and both have reacted with keloid growth. The second instance was a mother and daughter, who in a fire accident both were badly burned and both have reacted with development of keloids. For the rest it does not appear from the histories whether there has been any tendency within the patients' families to react with keloid growths, in spite of this point often having been directly questioned.

At the Radium Hospital all cases have been treated with radium, none with roentgen. In no case combined surgical and radiological treatment has been used.

The technique has been brachy-radium treatment with heavy filtering, relatively great radium-skin distance in proportion to depth of the suffering, and very protracted irradiation. Radium-mould with radium-skin distance of 0.7 cm. has been employed. Filter 0.7—1 mm. platinum. The moulds have been adjusted to render 6 Dominici units or about 560 r. in 24 hours. Every mould has been measured by the hospital physicist. As a rule it has been given from 15 to 22 Dominici units in one treatment, or about 1,410 to 2,060 r. Therefore it has extended over 3—4 days, which is a very protracted treatment.

The treatment has been tried adjusted to the probable radio-sensitivity of the individual keloid, age of the patient and of the keloid, its extension and elevation above the surrounding skin having been considered. One has tried to obtain the result with the smallest dose possible in order to produce the minimum of radio-changes in the skin.

Some of the keloids are we in future going to treat with near-distance roentgen therapy (CHAOUL).

The project of the treatment has been to obtain the greatest regression possible of the keloid, to remove subjective discomfort and to prevent recurrence. Regarding the visible changes in the skin, too heavy demands ought not to be made on the treatment. The keloid develops as a rule in a cicatrice, and the keloid itself produces atrophy of the skin also outside the original scar, the changes which in this way have taken place in the epidermis, together with the lack of normal skin structure in the epidermis as well as the lack of pigmentation and the dryness does not make a restitution possible. What is obtainable by radium-treatment is a flattening of the keloid down to or nearly down to level of the surrounding skin, and softening and some paling of the cicatrix. This regression appears only after 7—8 weeks and continues during several months, up to a year. After the treatment the patients have been controlled when the irradia-

tion reaction has ended, often after 2—3 months. By several such control examinations the regression of the keloid has been watched, and in case it has not given satisfaction, the treatment has often been repeated with the same technique as the first time, however with a somewhat smaller dose, 15—20 D. or about 1,410—1,880 r. Such repetition of the treatment has been made in 36 cases. After continued control examinations a third treatment has occasionally been given, so that the total dose has come up to 4—5,000 r. In a few cases small permanent radiation-changes have appeared in the skin, in form of small telangiectasias or depigmentations. In a single case it has been observed formation of a wound interpreted as radionecrosis, which healed after some time. The case concerned was a woman of 30 years, who previously has been treated abroad with a radium surface preparation. Radium-surface preparations have at the Radium Hospital in a few special cases been employed for ambulatory treatment of small keloids, and have not been included in this material.

In the above mentioned case of keloid growth in the oral mucous membrane, intubation of radium-needles was used. Dose: 72 mgrh. with excellent result, as a total flattening of the keloid and no recurrence occurred.

When trying to estimate the results attained by the treatments employed, it is difficult to find an exact expression comprising the total result obtained. In the present work it has been attempted to use regression and flattening of the keloid as a standard for the final results in the statistic settlement after 10 years of the treatment. Thus no impression is obtained of the effect of the treatment on the pain that goes with the keloids. However, the effect on the subjective symptom has in practically all cases been very satisfactory.

The result of the treatment estimated with a view to regression of the keloid has been put up as follows:

Table I

Very satisfactory regression	in	67	cases	or about	57 %.
Good regression	»	38	»	»	32 %.
Some regression	»	7	»	»	6 %.
No regression	»	1	»	»	1 %.
Unknown regression	»	4	»	»	4 %.

Very satisfactory regression here means complete or approximate flattening of the keloid down to the skin level, which was seen in 57 % of the cases. This group in the following has been called: Group I. Good regression has been used for those cases in which it still remains a distinct prominence of the keloid, but where at the same time there is a considerable reduction of the original growth. This group which in the following has been called: Group II, includes 32 % of the cases. Some regression

means that the keloid is somewhat reduced, modestly however, 6 % of the cases, later called: Group III. No regression was seen in 1 case, later called: Group IV. In 4 cases the regression has been described as unknown, because the patients have not met for control examination. Later called: Group V.

When studying the extent of the regression for the various keloids divided according to the releasing trauma, the following results are obtained:

Table II

	Group I	Group II	Group III	Group IV	Group V
Combustion and congelation	22	14	1		[1]
Injury by caustic agent	2	1			
Vaccination for smallpox	7	2	4		
Traumatic wounds	20	14	2	1	2
Operational cicatr.:					
1) Hypertroph. cicatr.	6	3			
2) Cicatricial keloid	3				[1]
Trauma at birth	1				
Unknown cause	5	4			

It is evident that the degree of keloid regression considered according to causality is apportioned over about the whole of the material, so that the responsible trauma seems to have no mentionable influence upon the sensitivity of the keloid to radium treatment. However, keloids in vaccination cicatrices are conspicuously numerous in Group III, i. e. many showing only some regression.

Hypertrophic cicatrices are known to react specially favourably to radium treatment. In the present material keloids in operational cicatrices have therefore been tried differentiated into hypertrophic cicatrices and cicatricial keloids. However, it cannot be seen that the hypertrophic cicatrices have reacted different from the cicatricial keloid, and not essentially better than the average of the total material.

Keloids with unknown cause do not differ essentially from the other keloids. It should be noticed that the keloid in the oral mucous membrane reacted very satisfactorily. The same is true for the keloid after the trauma at birth, the patient being treated at the age of 16 months.

Keloids in the skin over sternum have drawn special attention, and it may therefore seem reasonable to examine specially the reaction of keloids with this location. Thus it is found that these keloids seem to have reacted more poorly than the average, as only in 6 of 16 cases the regression is very satisfactory.

On examining the influence of the age of the keloid on the result of the treatment, the following is seen:

Table III

	Group I	Group II	Group III	Group IV	Group V
1st half year	26	4			1
2nd half year	15	15			1
2 years	11	7	2		1
2—5 years	6	3	2		
More than 5 years	9	9	3	1	1

First column, 1st half year, means the time from detection of the keloid until the treatment has commenced. From this it appears that the 1st half year all cases react favourably to the treatment, and as many as 26 of 30 very satisfactory. (The one case that did not return for control has been disregarded.) Already in the second half year the result is not so good. All here react favourably, to be true, but only 15 of 30 show very satisfactory result. In the 1st year no case shows poor reaction to the treatment, but in the 2nd year already, there are 2 cases that show only some regression, and later an increasing number of cases react less satisfactory to the treatment. On the other hand, many of the keloids still react very favourably after having existed for many years, and show complete regression. Thus a keloid in the cheek of a man, 67 years old, developed after a frostbite 30 years earlier.

When studying the influence of the patients' age on the result of the treatment, it is found:

Table IV

Ages	Group I	Group II	Group III	Group IV	Group V
0— 5 years	6	6			
5—10 »	6	3			
10—15 »	4	5	2		
15—20 »	10	3	2		
20—30 »	16	9	1	1	2
More than 30 years	25	12	2		2

Thus below the age 10 years all patients react well, and more than half of the cases very satisfactorily, but already in the group 10—15 years there are 2 cases that show only some regression, and the same holds for 15—20 years. The result from the groups above 20 years seems to be somewhat below the average, not much however. Influence of age of the patients on the result of the treatment seems on a whole to be somewhat less than that of the age of the keloid. The fact that children of less than 10 years show somewhat more favourable results than the average (see Table III), is possibly due to fact that the keloids in this group necessarily must be of more recent date.

18 of our patients had received surgical treatment of their keloids before arriving for irradiation. Only in 2 of these cases the surgical

treatment came so close to the irradiation that it could be considered a prophylactic postoperative treatment, as these cases were admitted for irradiation about 1 week after the operation. For the remaining 16 cases years passed between the surgical operation of the keloid and the radiotherapy. The 2 patients with postoperative irradiation both gave satisfactory result. For the 18 the results were: 9 very satisfactory, 5 good and 4 some regression, a result not essentially different from the material on a whole.

Most of the patients have complained of pain in the keloids in form of itching, stinging, aching, and that the keloids were sensitive to touch. For these discomforts the radium-treatment in practically all cases has had a favourable effect with complete disappearance of the pain, even though a couple of the patients still are complaining that they feel the pain. In these few cases the keloid has neither shown complete regression. The patients are almost always very pleased with the treatment, with the cosmetic result as well as with being relieved from the pain, and they often assure that it feels comfortable that the keloid becomes softer, the affected part feels less stiff.

In no case has recurrence of the keloid appeared, nor regression of the effect obtained by radium-treatment.

In forming an estimate of the results obtained, conditions in this country must be considered, the patients arriving from all parts, travelling long distances and therefore they have difficulties in meeting for control examination and continued treatment. For this reason they often declare to be satisfied with the regression obtained, even if the hospital would prefer to continue the treatment. Therefore the results might probably have been somewhat better if there had been occasion to treat all patients to such extent as had been considered secure and desirable with a view to avoiding permanent radiation-changes in the skin in this entirely-benign condition. As an example of such a case of unfinished treatment it may be mentioned the one patient who showed no regression of his keloid. He had received only one treatment with a radium-dose corresponding to 2,000 r.

The conclusion from the control examinations in the present material is that radium-treatment of keloid has given far more satisfactory results than any other method employed. The result is better the younger the keloid, and also partly better in children and in quite young individuals. Therefore it should be recommended that keloids come for treatment within a year from their detection, and then preferably for radium-treatment.

SUMMARY

A review is given of some of the more recent literature on keloids and on irradiation for this suffering.

At the Norwegian Radium Hospital it has during the decennium 1933—1942 been treated a total of 117 cases of keloid. Radium-treatment has been used, administered in heavily protracted radiation, often 1,400—1,900 r in the course of 3—4 days. The size of the dose has varied much, depending on the probable radiosensitivity of the keloid. The treatment has often been repeated after a year if regression of the keloid has not been satisfactory.

The result of the treatment has been that the regression of the keloid in 57 % of the cases has been very satisfactory, in 32 % regression has been good, in 6 % there has been some regression and in 1 % no regression. It appears that conditions for regression are most favourable in quite young keloids, preferably of no more than 1 year. The age of the patient also has some influence, as regression is greater in children and in quite young individuals than in older ones. The pain that goes with the keloid has disappeared in practically all cases. A keloid that regressed after radium-treatment has in no case shown tendency to recurrence.

ZUSAMMENFASSUNG

Es wird eine Übersicht gegeben über einen Teil des neueren Schrifttums über Keloide und über Bestrahlungsbehandlung dieses Leidens.

Im Norwegischen Radiumkrankenhause wurden in dem Jahrzehnt 1933—1942 im ganzen 117 Fälle von Keloid behandelt. Radiumbehandlung wurde gegeben, und zwar als energisch fortgesetzte Bestrahlungen, oft 1,400—1,900 r in 3—4 Tagen. Die Dosierung war sehr verschieden hoch, je nach der vermuteten Radiumempfindlichkeit des Keloids. Bei unbefriedigender Rückbildung des Keloids wurde die Behandlung oft nach einem Jahre wiederholt.

Das Resultat der Behandlung war in 57 % der Fälle sehr befriedigende Rückbildung des Keloids, in 32 % gute Rückbildung, in 6 % eine gewisse Rückbildung und in 1 % keine Rückbildung. Es scheint, dass die Voraussetzungen für eine Rückbildung am günstigsten sind bei ganz frischen Keloiden, am besten nicht mehr als ein Jahr alten. Auch das Alter der Patienten ist vom gewissem Einfluss, indem die Rückbildung bei Kindern und Jugendlichen stärker ist, als bei älteren Personen. Die das Keloid begleitenden Schmerzen verschwanden in so gut wie allen Fällen. Das nach Radiumbehandlung zurückgegangene Keloid hat niemals eine Neigung zum Rezidivieren gezeigt.

RÉSUMÉ

L'auteur passe en revue quelques-unes des publications les plus récentes sur les chéloïdes et leur traitement par irradiation.

A l'Hôpital Norvégien du Radium, on a traité, de 1933 à 1942, 117 cas de chéloïde. On a utilisé le traitement au radium, administré en radiation très prolongée, souvent de 1,400 à 1,900 r au cours de 3—4 jours. La grandeur de la dose a beaucoup varié en fonction de la radio-sensibilité probable de la chéloïde. Le traitement a souvent été répété au bout d'un an lorsque la régression de la tumeur n'a pas donné satisfaction.

Résultats du traitement: dans 57 % des cas la régression de la tumeur a été très satisfaisante, dans 32 % bonne, dans 6 % légère et nulle dans 1 % des cas. Les très jeunes

tumeurs, d'un an à peine, répondent très favorablement au traitement. L'âge du malade a aussi une certaine influence; la régression est plus sensible chez les enfants et chez les tous jeunes gens que chez les individus plus âgés. La douleur accompagnant la chéloïde a disparu pour ainsi dire dans tous les cas. Une chéloïde qui a rétrogradé après curiethérapie ne montre aucune tendance à se reformer.

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